PETROLEUM REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

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Editor

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THE LOOK BOX

First Blood

MEETING another industry in competition is something novel for oil. As the supplier of fuel and lubricant for automobiles, oil had competition within itself, none elsewhere. As it turned attention to materials of war its inter-industry competition almost ceased and it shouted in unison of its accomplishments in the war program.

In this it has come squarely up against another industry—alcohol, and it is doubtless true that in the public mind oil has come off second best. At the moment alcohol is providing more butadiene than is coming from oil and it has a larger butadiene plant than is operating on petroleum.

There were sound reasons for this. Colonel Bradley Dewey, Rubber Director, explained at Port Neches in February why priorities were granted for building all units simultaneously for converting alcohol into butadiene. The alcohol plants could be identical, hence one set of blueprints would serve and figuratively one shop could fabricate the equipment.

This was not possible for plants for petroleum conversion. Each has to be fitted into existing or building refining capacity. Three processes rather than one were possible in oil—thermal cracking; butane conversion, butylene conversion.

The Rubber Director did grant priority rating similar to alcohol for one of the butylene conversion units, which has been operating at the Baton Rouge plant of Standard Oil Company of Louisiana since June, 1943. But no one could expect the alcohol industry to admit that this plant is now producing butadiene at 125 percent of designed rating. The alcohol industry devoted its efforts to revealing that the alcohol plants are producing above designed ratings. The large plant of Carbide and Carbon Chemicals Company, Institute, West Virginia, designed to produce 80,000 tons of butadiene per year, is producing at a rate in excess of 100,000 tons per year.

All plants for alcohol conversion are complete. They were designed to produce 220,000 tons of butadiene each year. Time magazine credits them with the ability to produce at 50 percent above rating, 330,000 tons per year.

High priority ratings for these plants and their successful operation are responsible for the GR-S rubber program being on schedule, for alcohol is carrying 75 percent of the butadiene load. In the original allotment, petroleum was expected to carry 65 percent of the butadiene load.

But only one butadiene-from-petroleum got priority ratings comparable with alcohol.

Over the remainder of the year the full capacity of the petroleum plants will come into production. This will give the refining industry opportunity to match or surpass the excellent record of alcohol. Men familiar with the petroleum processes are confident that the plants will produce above designed ratings. If so, the end of the year will see butadiene production at a rate sufficient to give the nation more than the calculated 735,000 tons of GR-S rubber per year.

There has been some dissatisfaction over the bickering between the two industries. Inter-industry competition is an excellent attitude. It doubtless has had a part in keeping the total rubber program on schedule. Men may ask why any industry should brag in time of war. Bragging of itself is of little consequence. Cause for the bragging may be vital.

Furthermore the brush between the industries is

evidence that each considers chemical rubber something more than a wartime necessity. Both oil and alcohol expect to be making butadiene after the war ends. Each expects to dominate the butadiene field. Each has found a new product.

Chemical rubber is permanent. This does not imply that natural rubber will be ignored. But the chemist can make an elastic material with qualities superior to those possessed in the liquid that lies between the trunk and the bark of the tree Hevea Brasiliensis. To the extent that superior qualities can be built into these elastomers, they will supplant natural rubber as they should.

As for the industry that supplies the butadiene to make these permanent products, that again will be answered by competition. At least that should determine the source. And it will be no surprise if in the end it is alcohol which dominates as the raw material for butadiene; just as it will be no surprise if petroleum rather than grain or molasses is the raw material source for the alcohol.

Ho Hum

PERHAPS $30,000,000 is too trivial for much concern. At least there was no protest, not even from the petroleum industry, when the bill by which the United States Bureau of Mines got authority to study coal conversion passed both Houses of the Congress. If someone from petroleum circles had let a committee know that knowledge of coal hydrogenation is in the literature, that American technologists have dealt with it, that private capital will venture into it, at least the petroleum industry would have done its duty.

Whether the spending of that much money could have been prevented is doubtful. But the record should be kept clean and the conscience of an industry should not wither.

Some day there will be concern over spending such sums as $30,000,000 and the petroleum industry should never fail to speak its mind.

Over Sold

BOTH gold braid and the silver screen are being brought into firing position against the aviation-gasoline-plant building program. Evidently these 100-octane projects are not moving as they should. At least the Navy has designated some admirals as expediters, while OWI has prepared some motion pictures with appropriate words for convincing the pipe fitter and boiler maker that his work is vital.

Sometimes it seems that the lagging workman has been over convinced of his importance.

The man at work building a plant to make 100-octane aviation gasoline is making no contribution worthy of comparison with the contribution of the crew of a Flying Fortress. Any attempt to so impress the refinery workman is false in concept and impossible of application. Either the workman, knowing how little he deserves the accolade, will sneer and sulk or, becoming intoxicated by undue praise, he takes a few days off to live up to the false estimate.

Most of the men at work in refining plants keep on working regardless of the admiral and his gold braid or the motion picture on its silver screen. The few who are being courted by such means need a different approach—the designation of slackers.

Shortage And Why

ONE day soon the period of anxiety will come with first news of the invasion of Europe. Fate of men will have first consideration the world over. It is a move that must be made and can not fail.

Of minor consideration is the activity of the petroleum industry in keeping its customers satisfied with a limited supply of gasoline. The European campaign will demand more gasoline than previously used. The need will continue until the Allied armies are victorious. Meanwhile the domestic automobile will have less fuel, perhaps no fuel.

Just as the campaign can not fail, so the supply of aviation motor fuel must not fail. The amount must be twice enough, regardless of what it means at home.

The petroleum industry is following a wise course, however, in its preparation to inform the public why the shortage will exist. An informed customer is still a good customer, even when he can not buy.

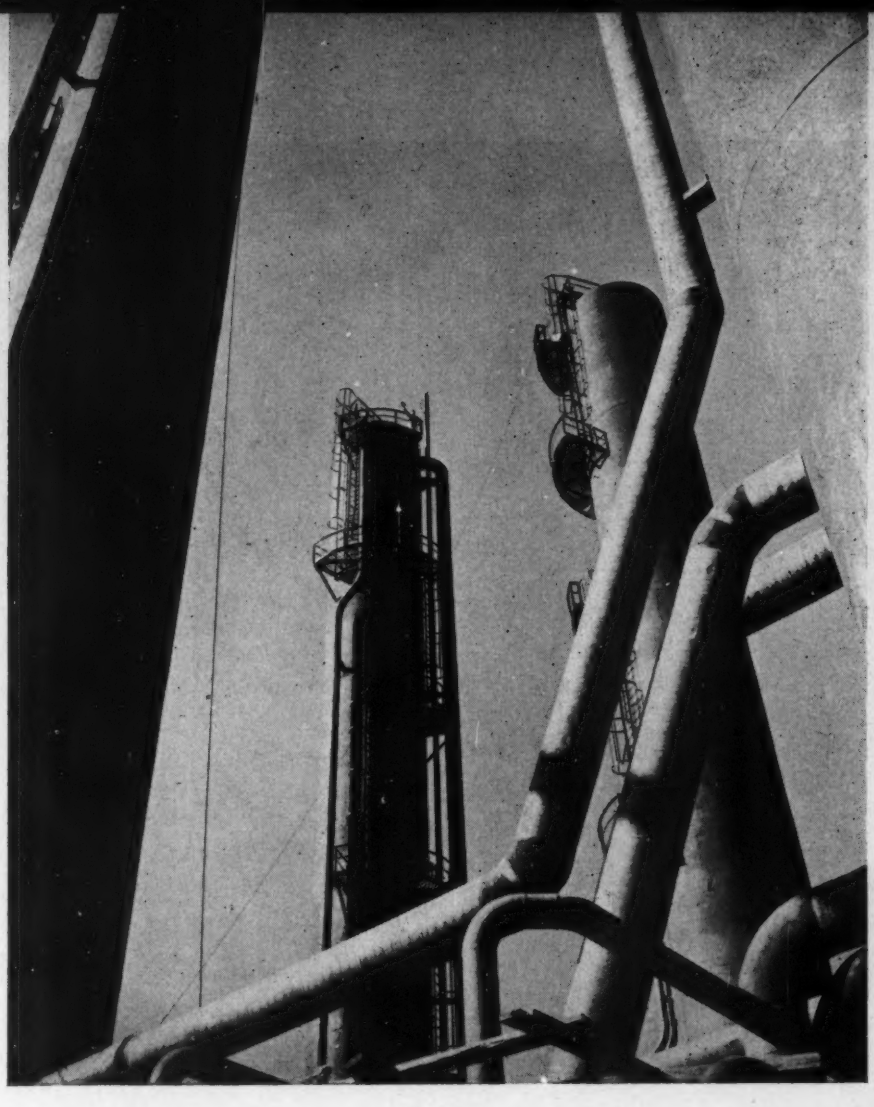
Another Pair

THIS number of PETROLEUM REFINER offers two thorough articles on products which have drawn little attention in the synthetic rubber program—styrene and carbon black. Somehow they have been overshadowed by butadiene.

Each is an essential. Like butadiene there are other sources of styrene, ingredient of GR-S rubber. But carbon black, a material for compounding, has no second or third raw material source. The quantities now demanded by industry are such that only the natural-gas reserves of the nation are equal the requirement.

It must be kept in mind that censorship restrictions are such that some details of manufacture of all ingredients of synthetic rubber must not be made public. Despite this, the authors have made interesting and complete presentations, which reveal uses other than rubber for each product.

Censorship had other influence on this issue of PETROLEUM REFINER. Illustrations for many of its advertising pages had to pass scrutiny in Washington. One consequence was that presses had to be held until approval was given.

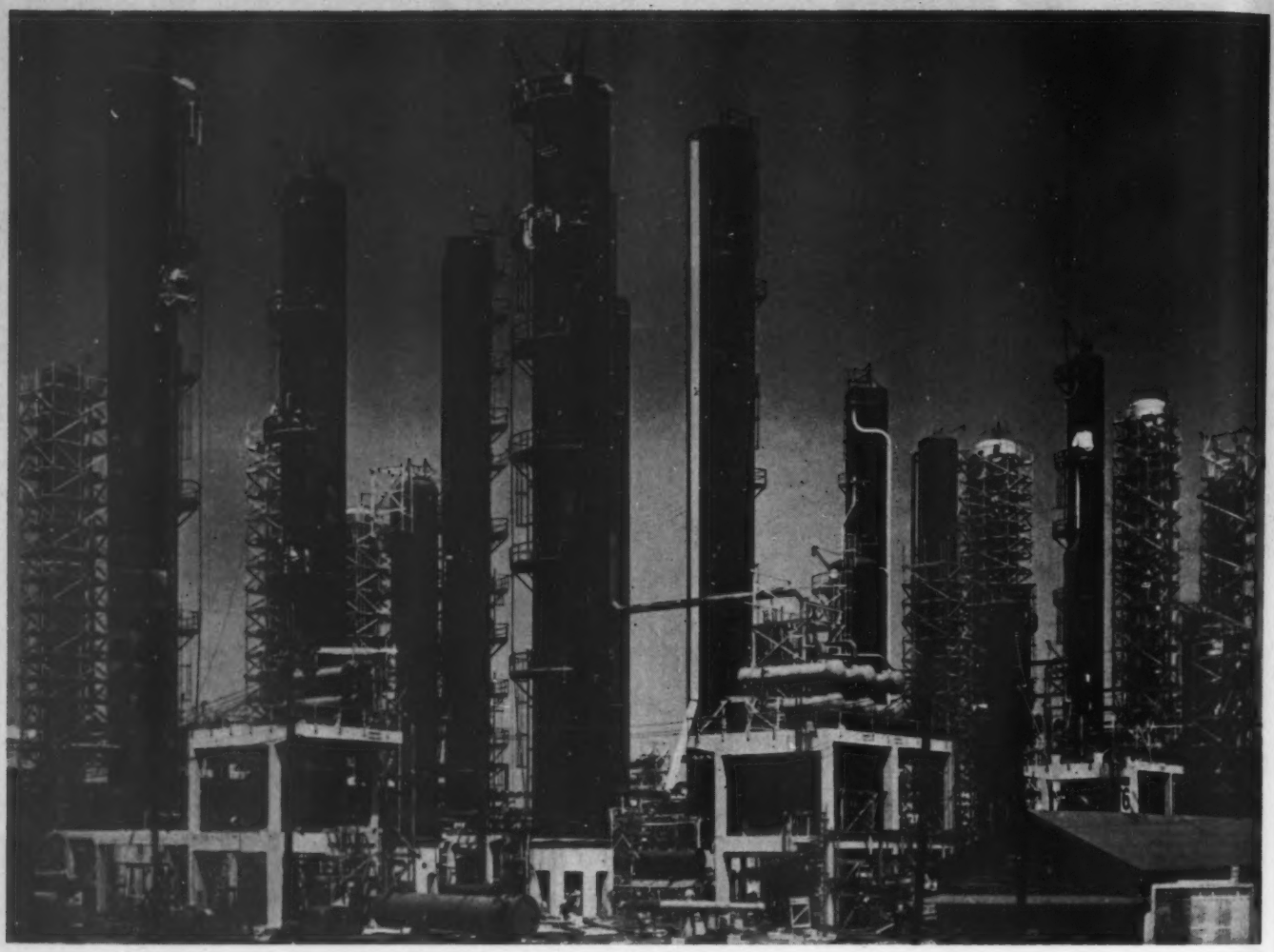


Port Neches Butadiene Plant Now on Stream

WITH completion of the first 50,000-ton unit of Neches Butane Products Company, Port Neches, Texas, in January, one of the largest of the plants for producing butadiene from petroleum, was placed in operation. Its ultimate 100,000 annual short ton output will be converted into 120,000 long tons of Buna S rubber in two adjacent copolymerization plants.

This combined project was financed through Defense Plant Corporation, a subsidiary of Reconstruction Finance Corporation. The three plants are being operated for Rubber Reserve Company, another RFC subsidiary, by corporations of the petroleum industry and the rubber industry. Neches Butane Products Company was formed by The Atlantic Refining Company, Gulf Oil Corporation, Magnolia Petroleum Company (Socony-Vacuum Oil Company, Inc.), The Pure Oil Company and The Texas Company. It supervised construction of the butadiene plant and will operate the facilities without management fee.

Rubber copolymerization is under the direction of Firestone Tire and Rubber Company and The B. F. Goodrich Company. Output of these plants will



North unit, half the plant capacity, under construction.

amount to more than one seventh of the total output of Buna S synthetic rubber in the United States. Styrene and other chemicals for the rubber conversion process will come from other sources.

The plant was formally dedicated February 23 by ceremonies at the plant and in Port Arthur. Officials of the five oil companies, representatives of agencies of the government and public officials had a part in the program.

In both construction and operation the plant at Port Neches represents an unusal cooperative effort within the petroleum industry. It is the only instance of so many refining companies pooling their technical accomplishments and manufacturing resources in a common venture. Through a series of committees the five oil companies put their technological achievements into a common working scheme, which will function as long as the plant is engaged in the rubber program.

To a limited extent the venture represents similar cooperative effort of the whole refining industry, as the committees had the benefit of developments within organizations other than the five active at Port Neches. In addition the commitee members were privileged to draw upon the experience of the chemical industry.

The plant is in the heart of the world's leading refining center—the Port Arthur-Port Neches-Beaumont area—along the Neches River, where five oil companies operate six refining plants, whose daily throughput is in excess of 500,000 barrels. Since these plants were designated early as a major part of the aviation-gasoline program, each either had or contemplated catalytic cracking facilities, which can be so operated as to produce high yields of light hydrocarbons, B-B cuts, as well as base stock for aviation fuels.

The Atlantic Refining Company, Atreco, will operate a fluid catalytic plant. Gulf Refining Company, Port Arthur, has both Houdry and Thermofor units. Magnolia Petroleum Company, Beaumont, also has Houdry and Thermofor plants. The Pure Oil Company, Nederland, is operating a Thermofor catalytic process. The Texas Company, Port Arthur, has a fluid-type catalytic unit in operation.

Assurance of a high yield of light hydrocarbons from these processes, from which an adequate supply of butylene could be taken, stamped the area as favorable for one of the largest of the butadiene units to be operated with petroleum as the raw material source.

Mainly from the fluid catalytic and Thermofor units of the five refineries the butadiene plant draws a typical B-B cut of normal and iso-butane, normal and iso-butylene along with limited amounts of C_3 and C_5 hydrocarbons. This combination feed is delivered by pipe lines into common storage. Since the butadiene process involves dehydrogenation of butylene, the first requirement in processing is removal of all other hydrocarbons from butylene. When this is completed iso-butylene, normal and iso-butanes and some of the other hydrocarbons are returned to

the five refining plants on a prorata basis. Here they can be processed by isomerization and alkylation into high-octane blending agents for aviation motor fuels.

Intricate Fractionation

There are three phases in the processing: extraction of butylene from the B-B cut; dehydrogenation of butylene in butadiene; purification of butadiene. Thermal heat, steam distillation, catalytic reaction, solvent extraction, acid treating, intricate fractionation and consequent condensation are the leading reactions in butadiene conversion.

As pictures reveal, fractional distillation requirements have dictated the provision of towers far in excess of similar equipment for a refining plant of similar capacity, 18,000 barrels daily. From the raw charge through all phases of processing and as finished material, the physical characteristics of the hydrocarbons are so closely related that only superfractionation is adequate for the separations that must be made during the three steps of processing.

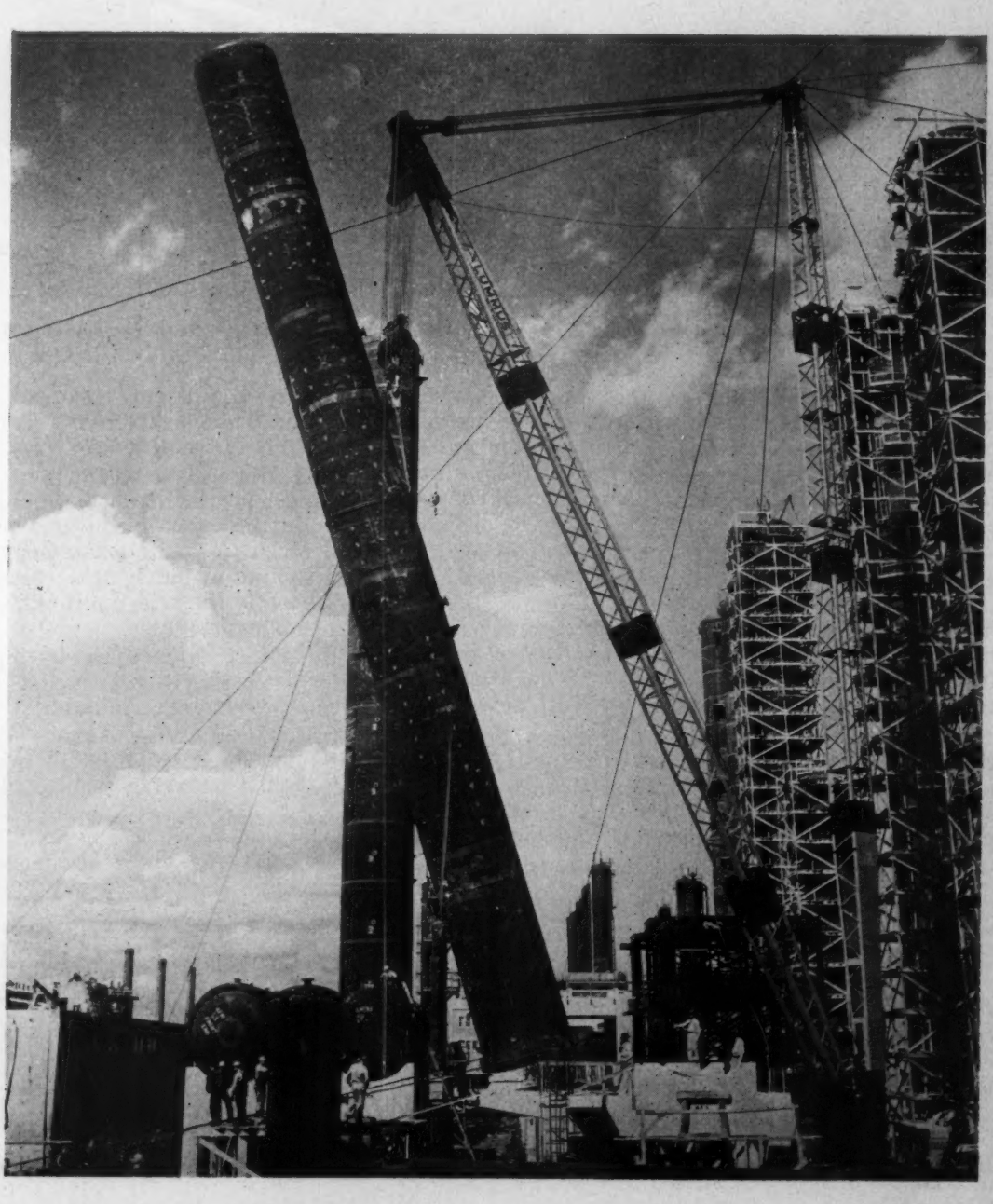
In the first step butylene extraction is accomplished by a combination of fractionation, solvent separation and acid treatment. About one third of the charge to this process is recovered as pure butylene for further processing. The remainder is compressed to liquid and returned to the refining plants.

Dehydrogenation, conversion of butylene into butadiene, is classed as a catalytic reaction, however, both thermal heat and steam injection are a part of the process. Relatively high temperatures and low pressures are involved.

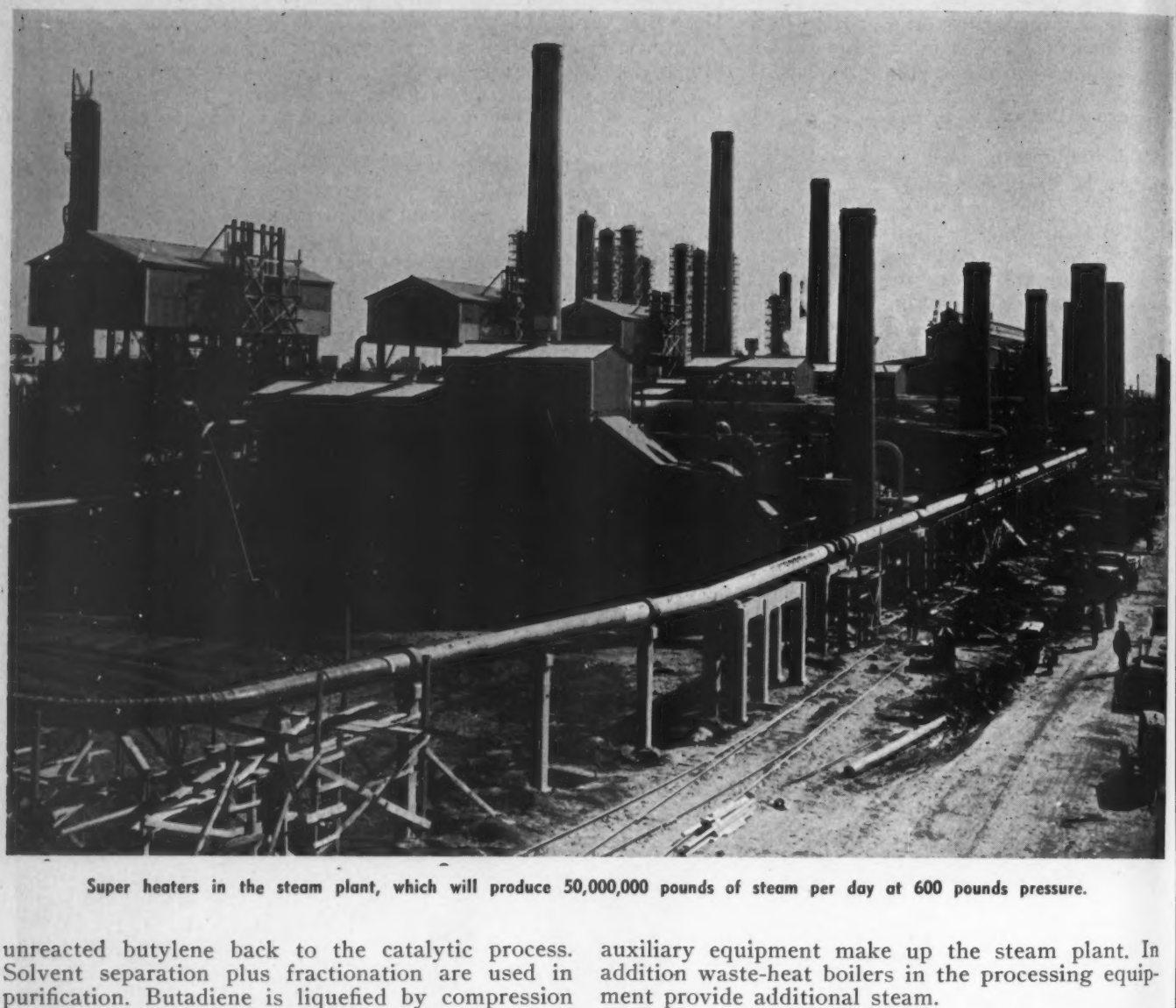
After the butylene charge has been through the furnace, it is mixed with superheated steam ahead of introduction to the catalyst chamber. This reaction is under rigid timing control by automatic instruments. Steam plays the role of protecting butadiene against decomposition.

Because of the brief reaction period only a portion of the butylene is reacted by removal of two hydrogen atoms from each molecule of butadiene. The unreacted butylene is recycled back through the dehydrogenation process continuously.

The third processing step, purification, feeds the



Forty-eight fractionating and processing towers were fabricated on the job



Super heaters in the steam plant, which will produce 50,000,000 pounds of steam per day at 600 pounds pressure.

unreacted butylene back to the catalytic process. Solvent separation plus fractionation are used in purification. Butadiene is liquefied by compression and pumped to pressure storage for delivery to adjacent copolymerization plants. A product of 98.5 percent purity is recovered.

The Port Neches plant is operated in two sections, each of identical capacity. Each has 21 towers in its three processing steps. In addition the north section has five additional towers for recovery and purification of solvents and one for separation of styrene from butadiene in the unreacted material that is returned from the two copolymerization plants.

The 48 towers were fabricated in a shop built especially for the plant. Abnormal expansion of refining facilities along the Gulf Coast had given commercial shops so much fabrication that The Lummus Company, general contractor, provided the new shop and used it for fabricating a few towers for other nearby contracts.

Steam Plant

Fractional distillation of hydrocarbons as closely related as butane, butylene and butadiene can be accomplished only by the use of extensive reboiler heating. Since steam is essential for this activity it is further used for pumping and for compressor power.

The steam plant is designed to produce 50,000,000 pounds of steam per day at 500 pounds pressure. Four boilers of special design and the necessary auxiliary equipment make up the steam plant. In addition waste-heat boilers in the processing equipment provide additional steam.

The first use of steam is at 450 pounds pressure as power for the major pumping requirements. These include the eight feed-water pumps for boiler feed and for feed to the waste-heat units; the pumps in the cooling-water system; pumps for handling the emulsion in the acid-treating stage of processing; the boiler-fan turbines.

Steam-driven compressors liquefy all vapors after each processing step as well as deliver finished butadiene to storage as a liquid.

Steam from these services is discharged into the 150-pound system, where its principal use is for driving pumps that transfer materials in the processing steps. Other uses at this pressure include the turbine drive in the refrigeration plant, fans, blowers and the drive for the compressor that supplies power for instruments. There is a limited reboiler use of steam at 150 pounds.

Additional steam at 150 pounds is provided by the six waste-heat boilers, which function on recovery of heat from the dehydrogenation process. These boilers generate steam at 298,000 pounds per hour.

Final use of steam is at 15-pounds pressure for reboiler heating. It serves all phases of processing at this pressure after which it is returned to the boiler plant as condensate and becomes part of feed-water makeup.

The boilers are gas fired. One is equipped for burn-

ing fuel oil along with gas. Each is equipped with a forced-draft fan, an induced-draft fan and a preheater. The compressor house has one unit for delivering air at 125 pounds for tube cleaning while the other maintains air at 80 pounds for instrument control.

Water Requirements

Boiler feed water is conditioned in a treating plant, equipped with seven filtering beds and six softening beds, designed to process 8,000,000 gallons per day. Of this 6,000,000 gallons are for boiler-plant use, 1,500,000 gallons are used in processing and in the treating plant, while 500,000 gallons represent loss in treating.

Further treatment of boiler feed is addition of phosphate compounds as the water is pumped to the boilers from the three soft-water reservoirs.

Cooling-water requirements are in keeping with the steam provision. This system is designed to handle 308,000,000 gallons of water daily. This is picked up from the Neches river a mile distant, put through the condensers and cooling equipment and returned to the stream. The magnitude of the cooling requirements can be appreciated when it is realized that the water requirement for Port Neches is equal to that of the city of Cleveland and a third of that essential to New York City.

Rotating, self-cleaning screens remove fish and debris ahead of suction of two gas-engine-driven pumps, which take water from the stream at the rate of 12,900,000 gallons per hour. The pumps can be electrically controlled from the plant. Their water volume is emptied into a conduit 22x9 feet and divided into three sections to permit one being out of commission for cleaning or repair as maintenance may require.

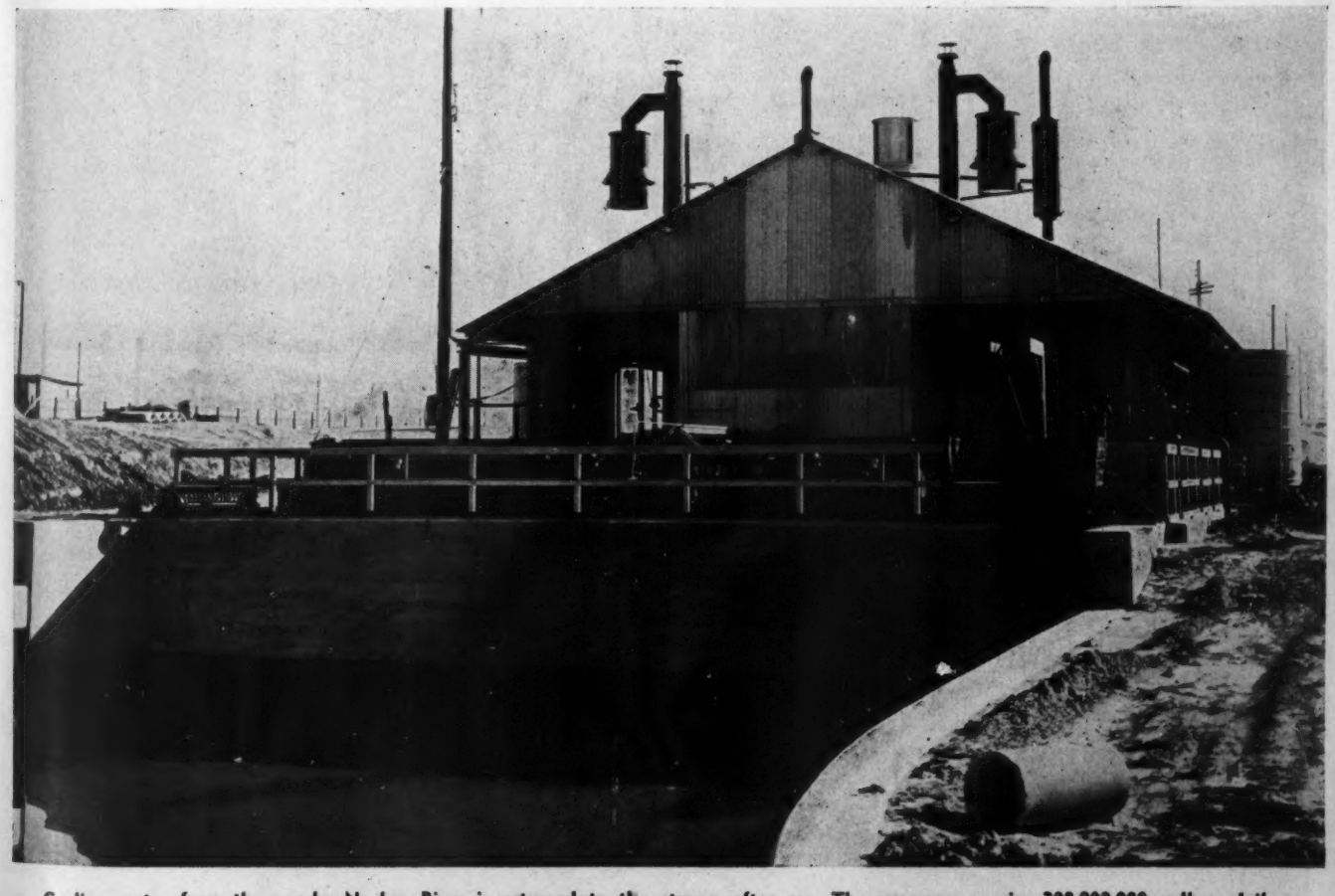
At the plant 10 turbine-driven centrifugal pumps take water from the conduit at 65 pounds head and put it into the cooling water main, a concrete conduit 66 inches in diameter. After serving the cooling units the water is delivered into another concrete main, eight feet in diameter, which empties into an outfall canal for return to the river.

History

The Neches Butane Products Company had its beginning January 12, 1942, when Herbert Henderson, vice president of Gulf Oil Corporation, went to Washington to confer with officials concerning the rubber prospects of the nation. Shortly afterward he conferred with officials of the four other companies whose plants are in the area, and they agreed to supervise construction and to operate the plant for the government without a management fee.

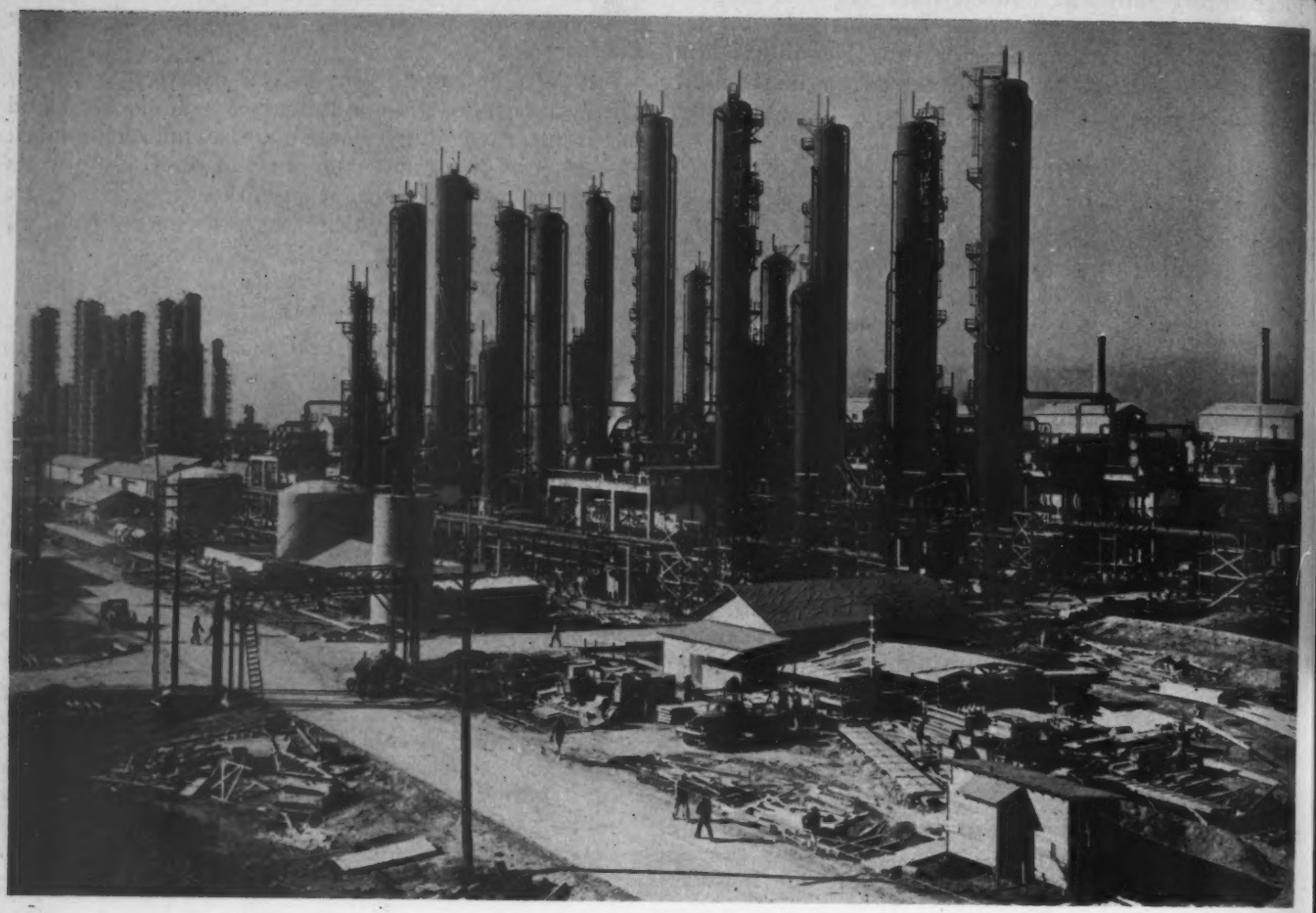
Accordingly, committees were named from the executive personnel of the five companies and March 20 they recommended that the plant be built at Port Neches and that facilities for making Buna S synthetic rubber be provided at an adjoining location. With approval of this recommendation Neches Butane Products Company was formed, a contract was made with The Lummus Company and work was started in June, 1942.

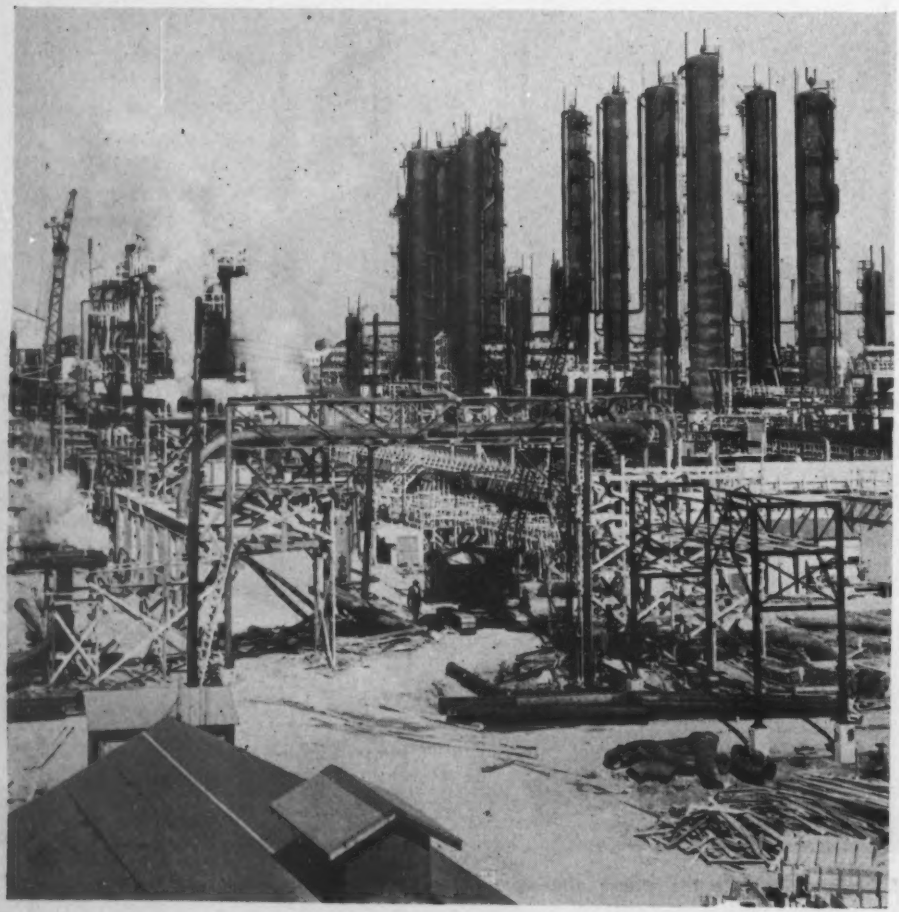
The plant represents a construction achievement. Despite labor and material shortages, one of its sec-



Cooling water from the nearby Neches River is returned to the stream after use. The processes require 308,000,000 gallons daily.

THE STAFF THAT SUPERVISED CONSTRUCTION

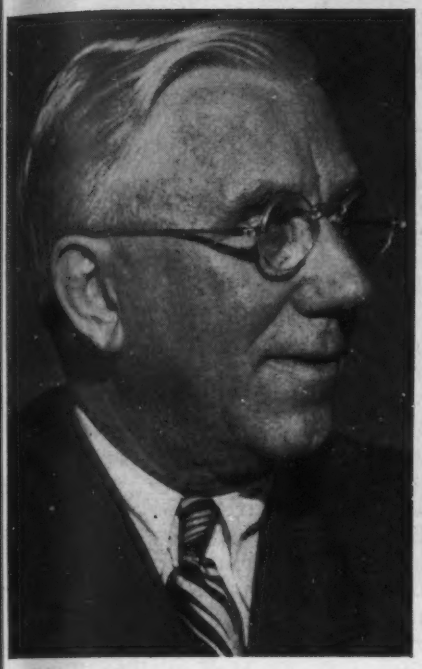




Among the construction handicaps was the problem of foundations for vessels and buildings.

The foundations required 11,830 pilings.

TIONTINUES AS PLANT OPERATING PERSONNEL



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Chairman of the Board

W. H. HOFFMAN
President

H. P. ARBUCKLE
Secretary

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MORTON MANDEL
Chief Process Engineer

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Asst. Secretary-Treasurer

R. S. CROCKETT
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Assistant Superintendent

HOMER D. MAPLES
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L. R. JONES
Chief Engineer

E. O. BENNETT
Personnel Supervisor

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Socony Vacuum Oil Company, Inc.

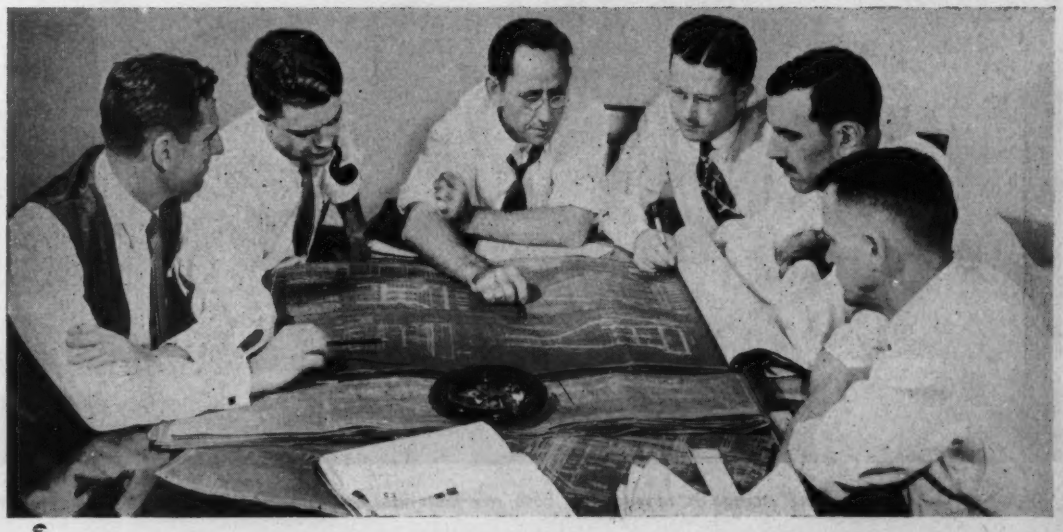
P. W. CORNELL
Gulf Oil Corporation

duBOIS EASTMAN
Chairman, The Texas Company

C. A. PORTER
The Pure Oil Company

A. H. SCHUTTE
The Lummus Company

M. J. FOWLE
The Atlantic Refining Company



tions was in operation 18 months after construction started.

So much similar construction was either underway or contemplated in Gulf Coast refining centers that personnel could not be easily provided. The immediate area had insufficient housing facilities and there was no living space available in Beaumont and Port Arthur. Finally a program of temporary houses and trailer camps was adopted under sponsorship of the government. These were expanded until facilities were available for the 7000 workmen who were required at the peak of construction. Water, lights, heat and sanitary provision had to be made for a population of this magnitude, as a requirement to building the plant.

After draining the 314-acre site, laying out roads and railroad sidings, engineers began probing for foundation formations. This problem finally was solved with the decision to drive pilings for all foundations, towers, pump houses, steam plant and even for pressure tankage. The housing, processing units and tankage of Neches Butane Products Company rests on 11,830 pilings, some 40 feet long.

Management of Neches Butane Products Company is through officials and committees, all drawn from the executive personnel of the five companies which formed the corporation. The officials are: Herbert Henderson, Gulf Oil Corporation, chairman of the board; W. H. Hoffman, president; J. B. Rather, Socony-Vacuum Oil Company, vice president; H. P. Arbuckle, Gulf Oil Corporation, secretary; F. W. Cooper, The Texas Company, assistant secretary-treasurer.

Directors are: E. H. Henry and W. F. Stroud, The Atlantic Refining Company; W. A. Slater and Herbert Henderson, Gulf Oil Corporation; C. B. Watson and J. P. Langfitt, The Pure Oil Company; W. F. Burt and J. B. Rather, Socony-Vacuum Oil Company, Inc.; H. Halpern and G. R. Bryant, The Texas Company; W. H. Hoffman.

Committees active in both management of the corporation and operation of the plant include:

Technical Committee: duBois Eastman, The Texas Company, chairman; P. W. Cornell, Gulf Oil Corporation; H. J. Fowle, The Atlantic Refining Company; J. Happel, The Texas Company; C. A. Porter, The Pure Oil Company; A. H. Schutte, The Lummus Company.

Legal Committee: Eldon Young, Gulf Oil Corporation, chairman; A. T. Foster, Socony-Vacuum Oil Company, Inc.; E. S. Morris, The Pure Oil Company; George W. Ray, The Texas Company; W. F. Stotz, The Atlantic Refining Company.

Patent Committee: A. M. Houghton, Gulf Oil Corporation, chairman; M. E. Birch, The Atlantic Refining Company; Donald Dickerson, Socony-Vacuum Oil Company, Inc.; Edward H. Lang, The Pure Oil Company; W. M. Stratford, The Texas Company.

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Insurance Committee: S. E. McKee, The Texas Company, chairman; W. V. Keeley, The Pure Oil Company; C. J. Heller, The Atlantic Refining Company; C. I. Richards, Socony-Vacuum Oil Company; H. J. Smith, Gulf Oil Corporation.

Public Relations Committee: James Tanham, The Texas Company, chairman; Byrne Bauer, Socony-Vacuum Oil Company, Inc.; C. H. Hathaway, Gulf Oil Corporation; F. M. Marling, The Pure Oil Company; Richard Rollins, The Atlantic Refining Company.

Pressure storage is required for both raw materials and finished products. The plant has 42 tanks.

When heated slowly under controlled conditions, liquid styrene (in the flask) is converted to solid polystyrene (center), which can be ground to granular molding powder (right).

Coloring can be added as desired.

Styrene, Buna Rubber and Polystyrene

W. C. GOGGIN

Manager, Plastics Development Department, Dow Chemical Company

MUCH has been written recently on styrene and the important part that it is playing in the synthetic rubber program. In view of the many articles now appearing on this subject, there is some possibility that the American public and American industry may temporarily be losing sight of the value of another important styrene product—polystyrene.

Polystyrene is a thermoplastic which can be molded, extruded or otherwise shaped into rigid articles of widely varied uses. Both in this country and abroad, it was known prior to Buna S type rubber.

The history of its development is as intriguing in many respects as that of its present illustrious cousin, Buna S. Styrene is believed to have been first isolated by Bonastre, a Frenchman, in 1831, but it was not until 69 years later, in 1900, that the commercial possibilities of styrene polymer were realized. In that year, Kronstein advocated its use in the preparation of varnishes. Eleven years later, Dr. F. E. Matthews of London, discovered the insulating properties of polystyrene and suggested its use in place of other insulating materials then available, namely, celluloid, ebonite, vulcanite, wood and glass. He also found

STYRENE is doubly significant to refining. Its applications are certain to expand as a plastic material; it can be made wholly from petroleum.

Its use in copolymerization of Buna rubber has drawn attention from what had been accomplished with styrene prior to institution of the synthetic-rubber program. This has allowed scant consideration of what may be done with styrene as a peacetime material.

Substantial amounts of the styrene going into Buna rubber come from petroleum sources. Ethylene may be had either from cracking still gases or from the cracking of propane. The benzene in use is doubtless from coal tar plants but it, too, could be taken from refining operations.

Styrene is a material of promise regardless of the scope of the chemical rubber industry after the war. This was graphically presented by the author as:

Well-Known Properties
Possible New Properties
New and Large Shapes
=
Low Cost
Greatly Expanded
Polystyrene Post War Applications

Polystyrene has proved useful in varied applications, such as kitchen appliances, combs, jewelry, bottle tops and medical equipment.

that polystyrene, when mixed with rubber, imparted to the latter some hardness and toughness, and he was quick to suggest its use in tires.

Its application, however, was not extensive, and developmental work on the material had not been carried to the point where it could be of any real value in World War I. Soon after the war, the interest in polystyrene was reawakened, and it appeared that this plastic might fill an important gap in the series of electrical insulating materials. Some work on polystyrene continued in Europe, but its use was yet very limited due to the difficulties of handling the relatively impure and expensive product then available. Some investigational work was started in 1933 in this country. It was hoped that this work would lead to improved production methods that would not only reduce costs, but would also produce a high quality material. This work did not appear to be very productive and was later discontinued.

Prior to 1935, the Dow Chemical Company realized the increasing need for a high-quality electrical insulating material. Such a product would not only permit better electronic control devices needed for its own manufacturing processes, but would also be useful over the extremely wide frequency range of 60 cycles up to even optical frequencies. By this time, the radio industry in this country had grown to very large proportions. Short-wave equipment, television, and other electronic devices operating at ultra high frequency were being thoroughly studied.

Successful Applications

In spite of the fact that other competent research laboratories had worked on the project and had not been able to produce a polystyrene of better quality than the imported German material, or to produce it at less than the import price of $1.25 per pound, it was decided to attempt what then appeared to be the impossible—to produce a high quality plastic insulating material. Dow's background of years of manufacturing experience in both aliphatic and aromatic hydrocarbons was extremely useful in the development of styrene, a member of the extensive alkylated aromatic family. After much study, a basic process was developed to the point where, in 1937, Dow Chemical Company offered to industry developmental quantities of purified high quality styrene.

Now came the problem of making this liquid monomer into a solid plastic material which could be put to practical use. The process on paper is extremely simple. It is only necessary to heat the styrene and, under proper conditions, it gradually becomes thicker and ultimately solidifies to a clear, glass-like plastic. When studied, however, the control of this apparently simple process becomes complicated by such factors as the necessity for extreme purity of the monomer, inhibiting materials, catalyzing materials, proper contact materials during polymerization, heating schedules for polymerizing. Again, the laboratories were confronted with a complex problem, and again, through diligence, it was solved. It now became possible to control the polymerization process and to make a granular thermoplastic molding material both in colors and crystal clear.

The commercial molders learned of Styron (Dow polystyrene) as an entirely new thermoplastic product, one with which they had not been familiar in the past. Its early price was somewhat higher than other molding materials; however, its unique properties and its future possibilities offered these molders a challenge which was readily accepted. After 1938, Styron's place in the increasing list of molding materials became assured, and as production and process efficiencies were improved, its use rapidly expanded. With this advantage, it became possible to offer this polystyrene at prices which would permit its direct

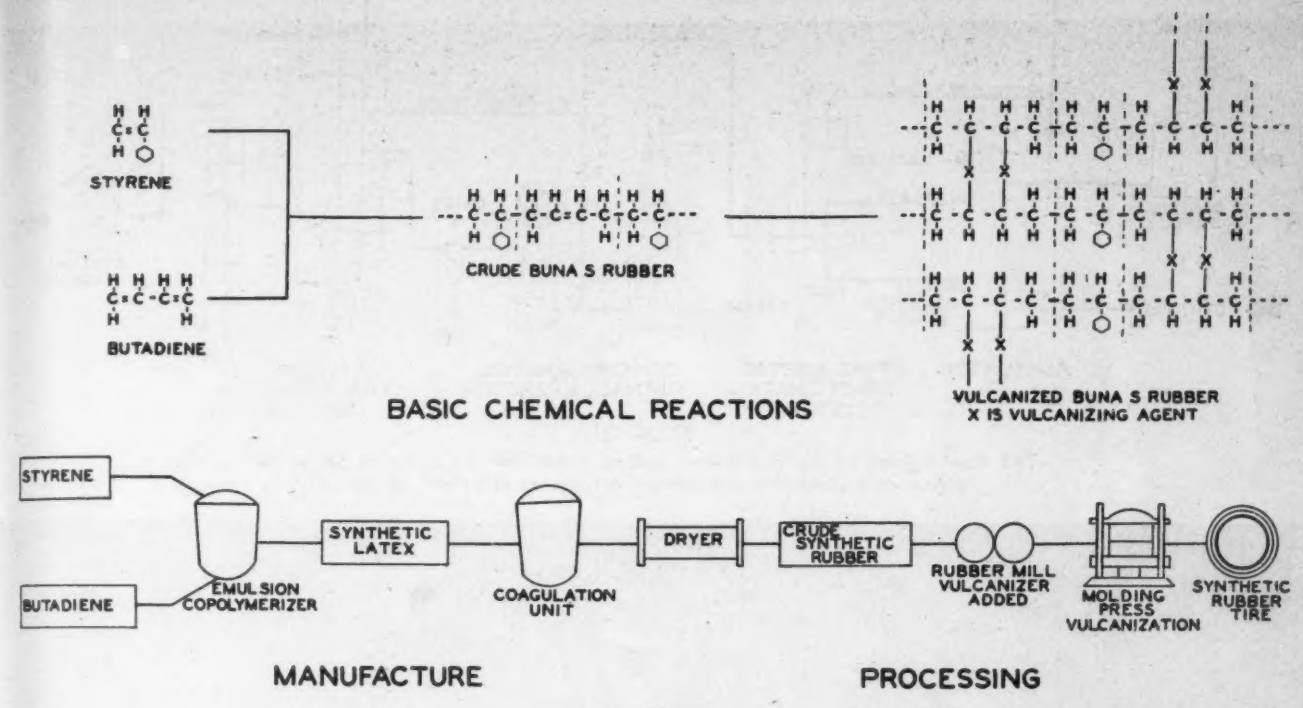


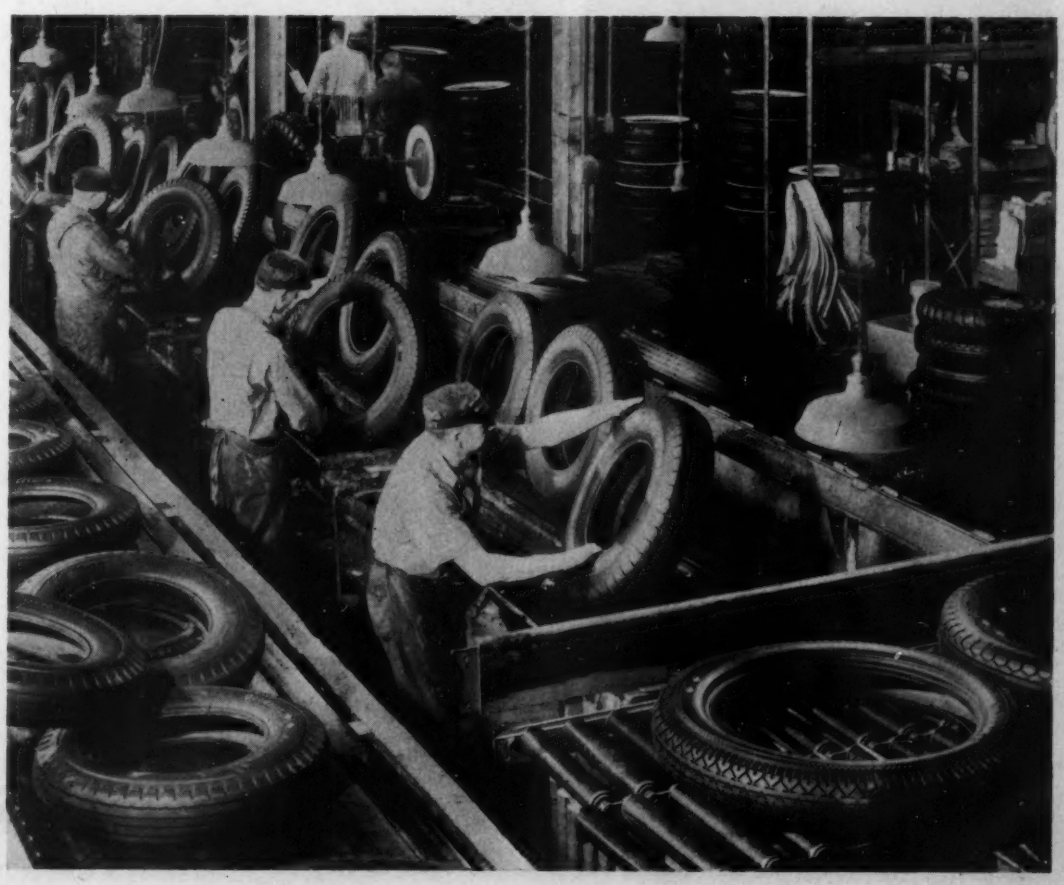
FIGURE 1

This diagram illustrates the method of making a synthetic rubber tire, indicating the basic chemical reactions which take place during the several steps of manufacturing and processing.

competition with other average priced thermoplastics.

As the unusual properties of polystyrene became more generally known, the material was proved useful in widely varied applications, in addition to those in the electrical field. Kitchen appliances, decorative building blocks, chemical resistors, lenses, camera parts, medical equipment, combs, jewelry and special displays are only a few of polystyrene's diversified applications.

Shortly before war was declared, polystyrene was reaching the plastics industry at a rate of well over half a million pounds per month. Its production had reached such proportions that it became possible for Dow to offer the material at a new low cost price of



Activity in tire manufacturing when natural rubber was plentiful.

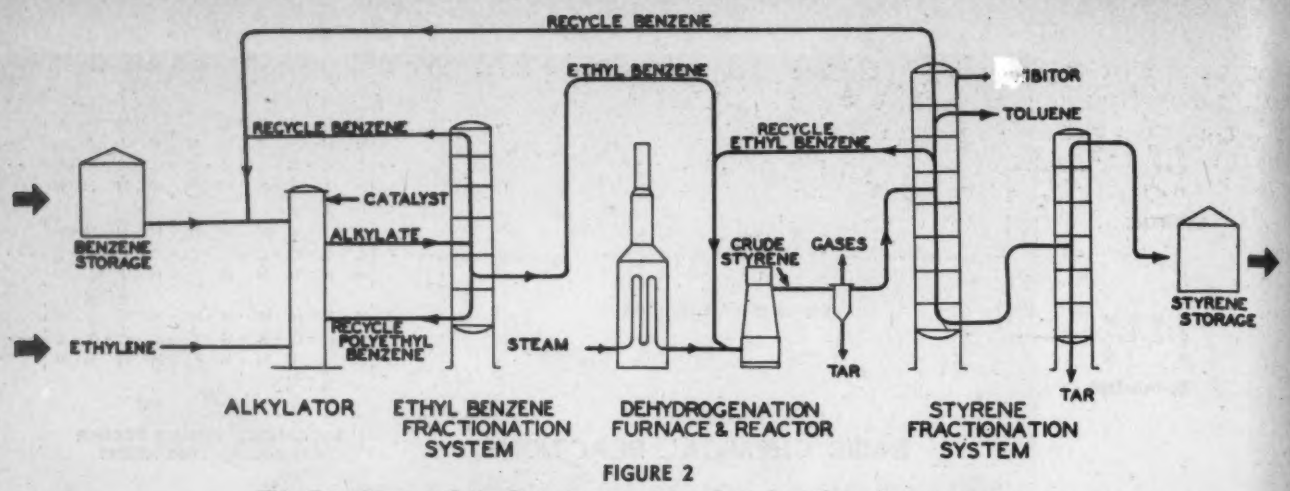
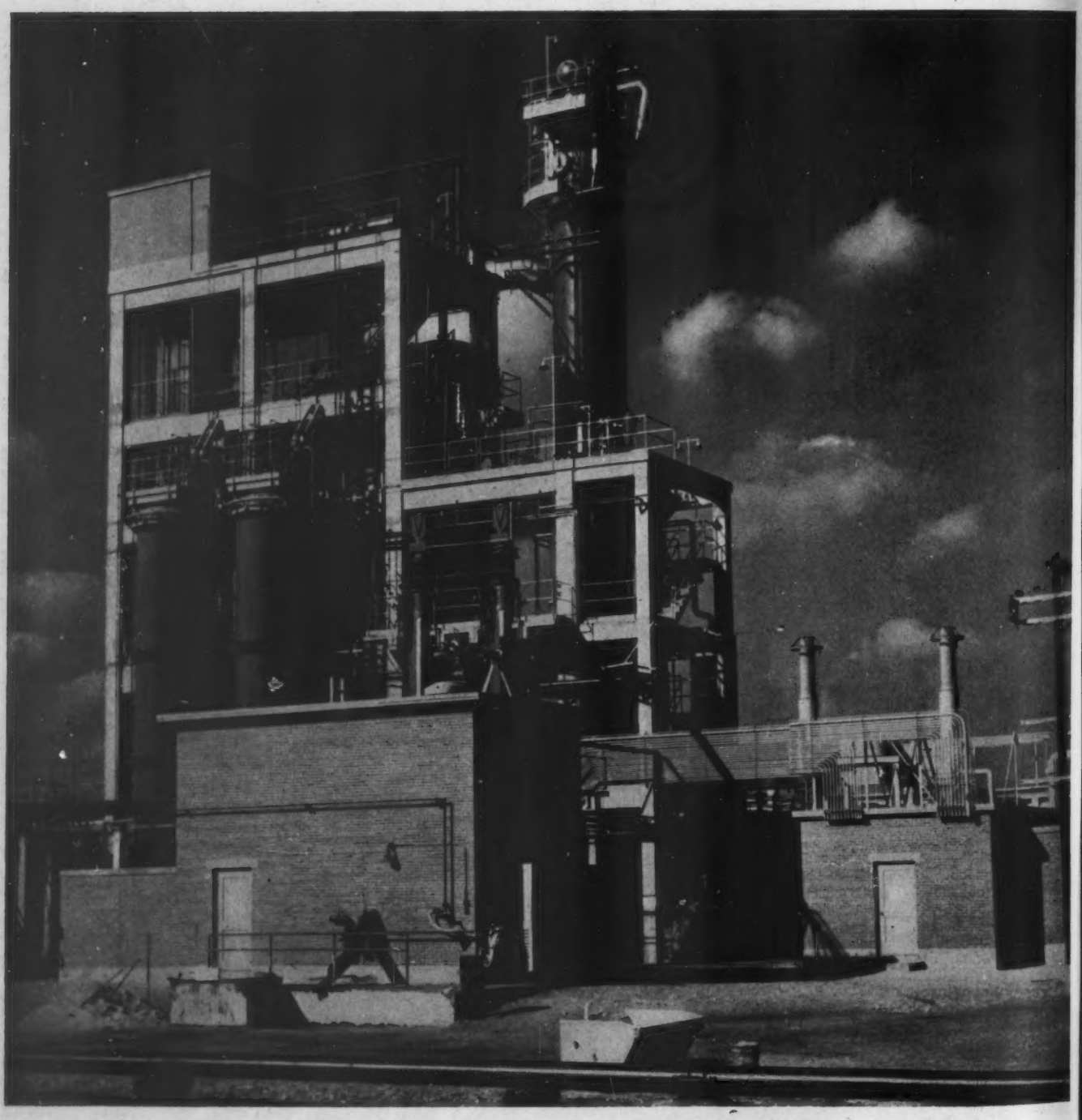
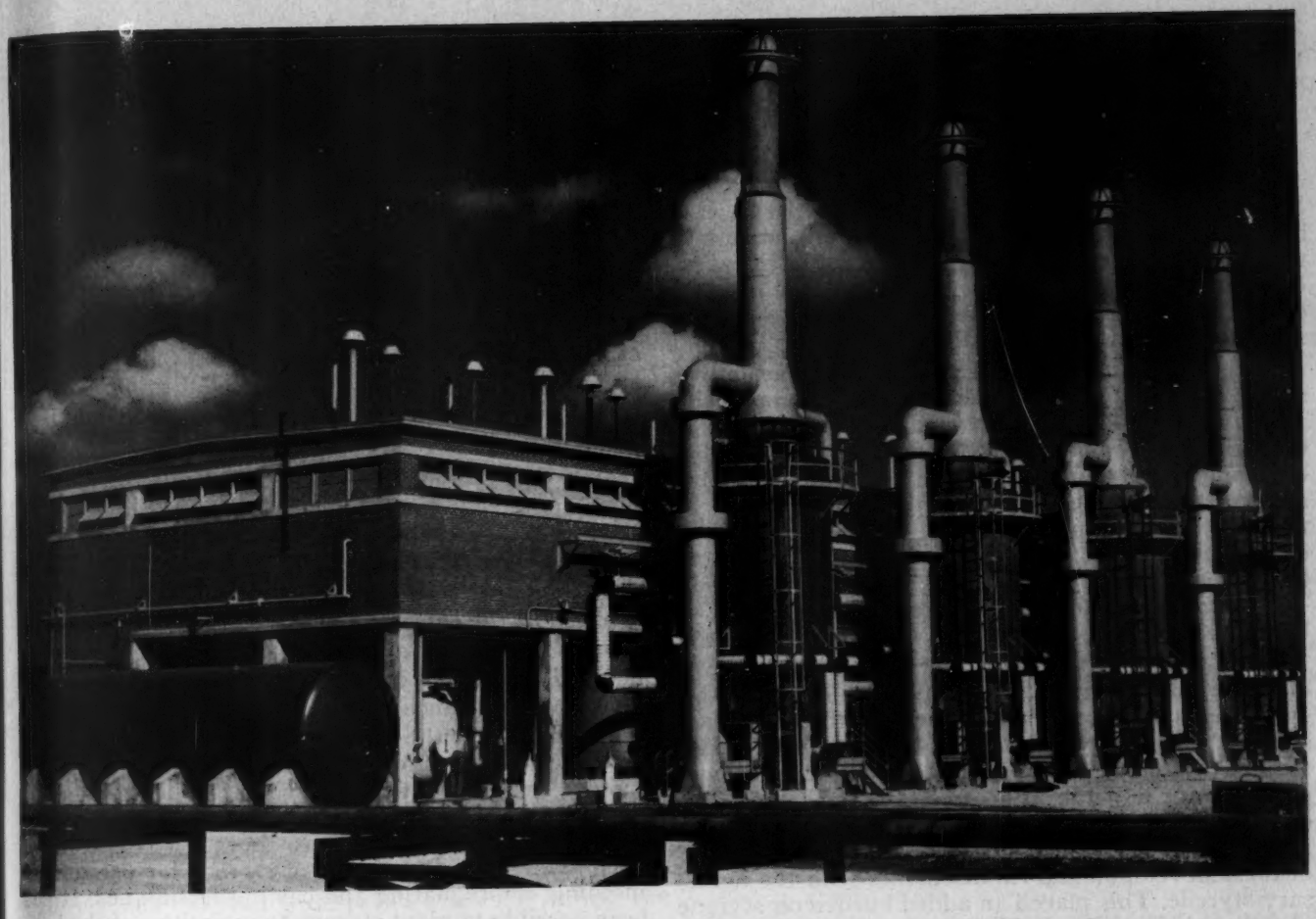


FIGURE 2

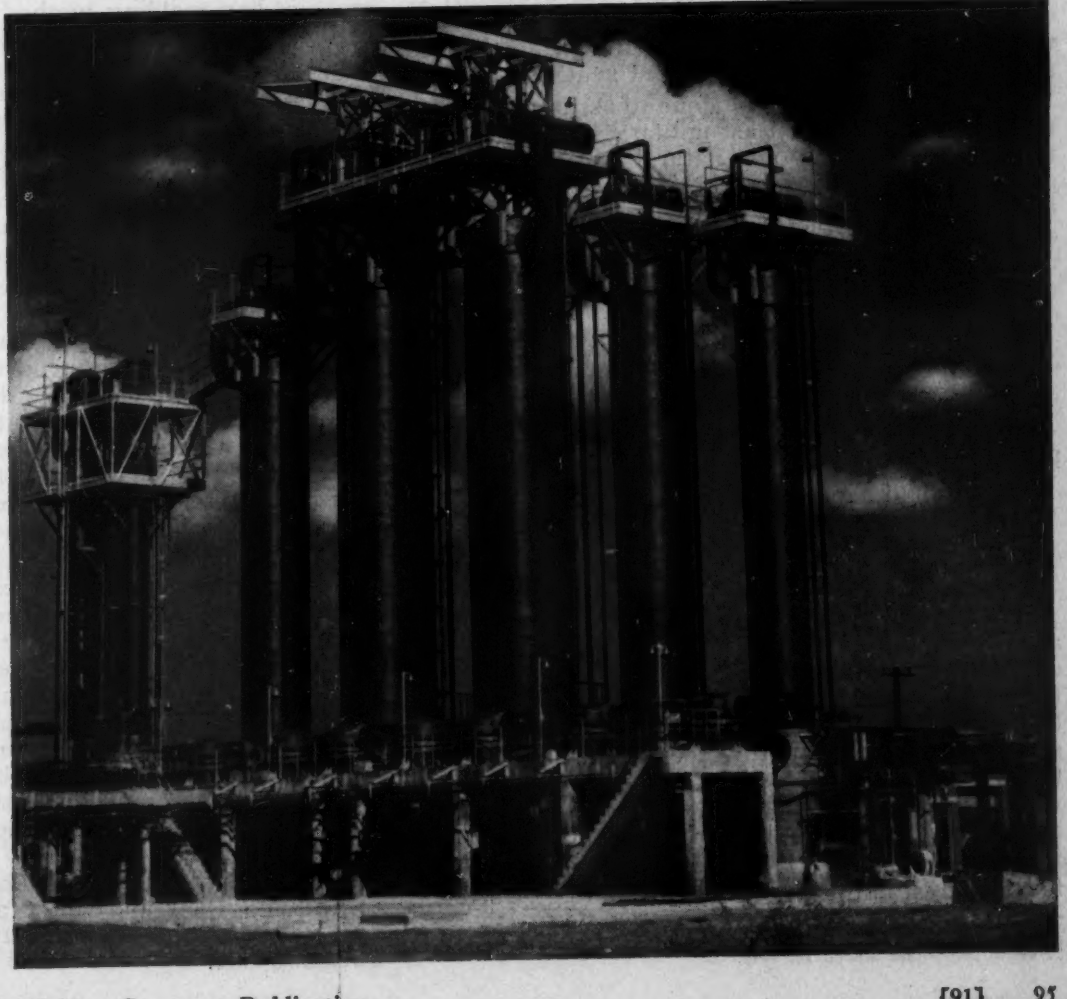
This flow diagram of the Dow styrene process shows how the units are set up as trains, each designed to produce a given amount of styrene per year.



The ethyl benzene unit at Velasco, Texas, an early step in the styrene production train.



The dehydrogenation unit at Velasco. This step in the process is commonly classed as cracking.



The styrene finishing unit at Velasco, where the largest of the plants of the Dow Chemical Company has been completed.

30 cents per pound. Compared to the previous import price of $1.25 per pound, this new low price represented real industrial advancement.*

Military Uses

And then the United States entered the war. Shortly, materials of many tyes became critical. One by one, supplies of imported products—special metals, fibers, rubber and others—were cut off. Plastics were called upon to alternate for and serve in the place of many of these critical basic materials. As a result, most plastics also became critical.

Without a doubt, the most critical large scale war raw material shortage was that of rubber, practically all of which had to be imported. Research work in this country by chemical companies, by the rubber companies, and by some of the oil companies, had shown that a practical synthetic rubber could be made of styrene and butadiene. Work on a similar composition had been under way in Germany and had, by this time, reached large scale proportions. The styrene-butadiene synthetic rubber product is known as Buna S, Figure 1.

Up to this point there had been, due to the low cost of imported rubber, little incentive for carrying this synthetic rubber development beyond the semi-plant stage. With our entrance into the war, this small-scale synthetic rubber development program was given terrific impetus; it became of major importance overnight. It became necessary for Dow, the sole domestic, large-scale producer of styrene, to supply all of these developmental rubber plants with the necessary styrene. This placed an added burden on styrene plants and much less polystyrene was available. It could now be obtained only for those applications which were of sufficiently critical military importance to equal that of the sorely needed synthetic rubber.

But something had to be done to assure this country and its allies of at least military supplies of synthetic rubber. It was only natural that the Dow organization with its wide experience in the manufacture of styrene, and by this time, butadiene, was called on to assist in the design, construction and operation of plants to produce basic materials for the rubber program. Now the Dow styrene process, outlined in Figure 2, is used in four of its own plants and in part by two other plants. The process is scheduled to produce nearly 90 percent of the styrene demands for the rubber program.

The basic chemistry of styrene production by the process is relatively simple. It involves:

1. The alkylation of benzene with ethylene to form ethyl benzene.
2. The dehydrogenation of purified ethyl benzene to give styrene.

Ethylene gas and benzene enter a tower operating at essentially atmospheric pressure, using aluminum chloride as catalyst. Here alkylation takes place to form ethyl benzene, diethyl benzene and polyethyl benzenes. The crude ethyl benzene so formed is then sweetened and distilled to give pure ethyl benzene. Other products separated in this step are benzene, which is recycled, and the polyethyl benzenes, which are returned for de-alkylation to ethyl benzene.

The ethyl benzene is then dehydrogenated over a fixed catalyst in the presence of steam to give styrene and small amounts of benzene, toluene and tar. In the distillation step, these components are separated at reduced pressure to give benzene for recycling, ethyl benzene for recycling, toluene as a by-product, and styrene at 99.5 percent or higher purity is produced. The fractionation step is a delicate one due to 9° F. difference in the boiling points of ethyl benzene and styrene. In addition, styrene, under these conditions, has a strong tendency to polymerize. The proper combination of high-vacuum-distillation technique plus suitable inhibitors has made a routine operation out of an extremely difficult problem. Before storage or shipment, styrene is cooled to 60° F., and a few parts per million of a polymerization inhibitor are added.

It is now a matter of history that all the styrene plants engineered and supervised by Dow are operating. Further, the plants are capable of producing in excess of design capacity and the styrene quality is over the established specification for rubber.

Much of the research and engineering effort in the field of styrene during the war has, of necessity, been devoted to detailed engineering and production problems of importance in the manufacture of styrene itself. However, the military applications of polystyrene have not been forgotten. In addition to the many molded forms in which polystyrene is being used for electronic equipment, optical equipment, and special chemical resistant equipment, thorough studies have been made of various forms of styrene for use in new molding, impregnating and casting techniques. It has been possible to adapt styrene to variations of the low-pressure-bag molding methods. This means it now becomes possible to produce laminated structures of almost unlimited size based partially on styrene. The process involves laying up fabrics of glass canvas, or other suitable materials, which have been impregnated with styrene and other constituents over proper forms, enveloping the forms in a vacuum bag, and then applying heat to polymerize or harden the monomeric constituents. The result is a rigid, large size, semi-structural molding, heretofore impossible.

One other important interest in expanding polystyrene's fields of application has been to increase the upper limit of operating temperatures. Basic polystyrene cannot be recommended for operation at temperatures of over about 180° F. This means that its application in any field is limited to locations where heat does not become excessive. Otherwise, deformation would take place. However, new compounds based on styrene or polystyrene are being rapidly developed which definitely raises this top operating temperature.

No one knows, as yet, the extent to which styrene produced by the plants designed for the rubber program will be available for the production of plastic materials after the war is over. It is reasonable to expect that a fair proportion of the production may, however, reach the plastics field. If this is the case, it is also probable that even the present 30-cent basic price of polystyrene will be reduced to the point where it becomes unquestionably the least expensive, practical thermoplastic molding material. Because of the foresighted work done by research laboratories during the war, America may look forward to a future of strikingly new and varied advances in a plastics field where styrene and polystyrene will be playing a leading role.

*The Dow Chemical Company reduced the price of polystyrene to 27 cents per pound March 10, 1944.

CARBON BLACK

J. F. GALLIE,

Natural Gas and Natural Gasoline Division, Petroleum Administration for War

ONE of the less publicized tasks assigned the Petroleum Administration for War is that of supplying natural gas to the nation's manufacturers of carbon black—the phoenix in whose form it rises anew to perform strange and miraculous duties. It is a tribute to the natural-gas industry, hard-pressed during the enormous industrial expansion of the past three years, that gas has been made available for increased production of carbon black, production which even in pre-war years required the burning annually of some 350 billion cubic feet, or well over 10 percent of annual marketed gas production. Yet, while the petroleum industry's role in the creation of synthetic rubber has received widespread attention during the two-year period in which the nation has been made distinctly rubber conscious; while the public has seen "bathtub" rubber created in surroundings reminiscent of moonshining days; while it has heard, frequently and alternately, that tires made of synthetics will outlast the car equipped with them—or will go flat in the driveway; and while the creation of synthetic rubber has received attention in magazine and text, radio and screen script, the product through the medium of which those words were printed, and one which has been used in tire manufacture for the past three decades, saving the motoring public billions of dollars through its three-fold increase of tire life, has received scant attention.

This is the more strange when the role of this submicroscopic derivative of natural gas in today's synthetic rubber program is evaluated. Natural rubber tires were in use, although limited to about 3000 miles of wear, before carbon black was determined to be an essential ingredient in rubber compounding. What of synthetic rubber? The following quotations provide some measure of its utility in tire compounding.

> Buna S in the pure gum state is practically worthless. The tensile strength is around 200 pounds per square inch and the material is almost devoid of tear resistance[1].
>
> . . . in Buna S the role played by carbon is not merely, as in natural rubber, essential, but is, in fact, sensational. Tensile strength is improved not by 25 but by 600 percent. . . . Buna S is utterly dependent on colloidal carbon for strength.[2]

Synthetic-rubber production will near its peak this year. In 1941 production of synthetic rubber ran about 10,000 long tons; this year it will exceed 800,000. The petroleum industry may well be proud of its part in the creation of this gigantic industry, which received the 1943 Award for Chemical Engineering Achievement.

But if the production of synthetics was yesterday's problem, their processing is today's. The development of this situation was considered in PETROLEUM REFINER as early as October, 1942, when it was stated in a special "War Products Issue" that: "Petroleum refining alone is not charged with providing a million tons of synthetic rubber each year. It is building plants to assure three fourths of the butadiene and part of the styrene that make the Buna rubbers. These in turn must be taken by the rubber industry for working into something akin to crude rubber and finally shaping into usable articles . . . It is well for the petroleum industry to realize that tire moulding is no part of the plants now building."

> **The manufacture of synthetic rubber is only a means to an end. The real problem is assurance of tires for cars and trucks, rubber parts for tanks, airplanes, and submarines, rubber boots, coated fabric, hose, and thousands of other useful and essential articles so necessary to our way of life. W. L. Semon[24]**

Where the role of petroleum has left off, the role of natural gas, which Deputy Petroleum Administrator Ralph K. Davies has aptly termed "oil's fighting ally," has begun. Under Director James E. Pew, PAW's Natural Gas and Natural Gasoline Division is assuring a steady flow of raw material to the carbon-black industry. But the task of coordinating supply with demand—taking natural gas and converting it into a product suitable for use in the Office of Rubber Director's tire compounding program—is one which rests principally upon the War Production Board's Pigment and Color Unit, headed by Thomas J. Starkie. Chief Starkie and his capable aids, Assistant Chief Charles H. Love and Goodwin Bangsberg, early foresaw the need for the various types of carbon black which has since arisen, and undertook immediate expansion of the industry. The result has been that rubber industry needs have been filled even before they have developed—there has been no tragic "too little and too late" in this highly critical aspect of the compounding problem.

This is the more remarkable in that initiation of this huge industrial expansion, which this year will result in the production of nearly three times as much furnace black as was produced in pre-war years, predated the Report of the Baruch Rubber Survey Committee. If tires and tubes are made available for civilian use in appreciable quantity this year, it will be due to the foresight of Chief Starkie and the

Courtesy, Columbian Carbon Company

FIGURE 1

Ancient Chinese method of producing lampblack by impingement.

courage of the carbon-black industry in expanding production prior to market demand. These factors have not only made possible early large-scale production of synthetic tires and tubes, but have stretched America's limited crude-rubber stockpile over the past two years of battle—stretched it far beyond the ability of rubber itself.

Certainly no phase of the synthetic-rubber program is more closely related to the petroleum industry than that of carbon-black production. Until the latter half of 1943, alcohol provided the principal source of butadiene for synthetic rubber production. On the other hand, carbon black, which is of fundamental importance in the compounding of both natural and synthetic rubber, is wholly of the petroleum industry. It is, then, deserving of particular attention at this time, for Rubber Director Dewey has signified that this is the truly critical period in his program—the period in which synthetic rubber must be converted into the tires on which the United Nations will roll to victory.

History of Carbonaceous Pigments

The history of the carbonaceous pigments is history itself. When man first began to record his actions and thoughts on skin and bark, he made use of writing fluids with carbonaceous bases, obtained from charred bones or vegetable matter. Lampblack, obtained from the combustion of carbonaceous liquids and solids, had its origin in China. It formed the basic ingredient of the ancient Chinese stick ink, and with its aid, Wei Tsu, in the third century A. D., developed our present-day ink. There, too, Wang Chieh printed the first book some five centuries later.[3]

Between the time lampblack was first produced in China and the manufacture of carbon black from natural gas was begun in the United States, related methods of preparing lampblack were developed in Europe. One source[4] notes that: "Vitruvius (80 B. C.) gives detailed instructions for the preparation of lampblack or smoke carbon, and carbon pigments of either the char or lampblack varieties were known to most of the ancient civilizations, including the Arabian and the Indian. However, none of these pigments was true impingement carbon black . . ."

The Chinese burned oil beneath inverted ceramic cones or bowls, as shown in the old print reproduced in Figure 1, to obtain a high grade of lampblack, all qualities of which have not been duplicated elsewhere. The fine lampblack so obtained was removed by hand every 20 minutes. The importance of these basic principles: permitting the carbon to impinge upon a cool surface—provided by the Chinese in the smooth faces of their inverted bowls, and later by the Americans in soapstone slabs, metal discs, plates, and rollers, and finally steel channels—and removing the carbon early from the impingement surface, thereby preventing any alteration in the physical properties of the end product, was not generally recognized prior to development in the United States of impingement processes for carbon-black production. Today, according to the source last quoted, lampblack made by the same ancient process in the interior of China most nearly approaches ordinary grades of carbon black in desirable qualities.

About 1825, it has been reported, attempts were made in both England and America to produce colloidal carbons from manufactured gas. But such plans were not economically feasible, and lampblack remained until after 1864 the pigment used in printing inks. In that year, J. K. Wright, a printer in Philadelphia, initiated limited production of carbon black for his own use. This black, distinguished from lampblack through its derivation from gaseous hydrocarbons, rather than carbonaceous liquids or solids, was produced by impingement of artificial gas flames upon a revolving sheet iron cylinder and collecting the carbon with a hand scraper.

United States Patent 72068, the first covering carbon-black manufacture, was issued to Adolph Millochau of New York City. However, his method proved to be valueless, and it was not until 1872—46 years after natural gas was first used for lighting, in Fredonia, New York—that a plant was erected at New Cumberland, West Virginia, under a patent issued to John Howarth. This plant made use of ventilated soapstone slabs or benches, cooled by running water, as the depositing surface, with the carbon collected thereon being scraped off periodically by hand. The first 500 pounds of carbon black so obtained sold for $2.50 per pound, the next 1000 at $1.50, and the wooden plant paid for itself in three months. Shortly thereafter it burned to the ground, and its successor, erected in Saronsburg, Pennsylvania, made use of cast iron rather than soapstone, and traveling scrapers for collection.

Peter Neff, at Gambier, Ohio, was second to enter the commercial field. Of the patents issued to him between 1875 and 1885, most were of slight value. In 1879, A. V. Nolen began manufacture, making use of iron pans holding water as impingement surfaces. Competition further reduced the price, and by 1882, when Samuel Cabot entered the business, carbon black was selling for 31 cents per pound. At this time, gas was considered a waste product, and that not entering the plant was permitted to blow to the air. A little gas was then used for lighting and heating, but it likewise was not metered, being sold on a fixed-charge basis. This naturally resulted in excessive use and waste. Cabot's contribution to the science was the elimination, through flow control, of at least part of this flagrant waste.

In 1883, L. Martin introduced the use of 24-foot rotating plates as collecting surfaces, and A. R. Blood

began manufacture similarly using 3-foot discs, which had the advantage over the larger plates of not requiring that the collecting surface be pierced for ventilation. In the same year E. R. Blood patented a system whereby small round flames were impinged upon a roller, producing a high grade finely divided carbon. Essentially this same method is still used for the finest embossing and lithographing ink blacks.

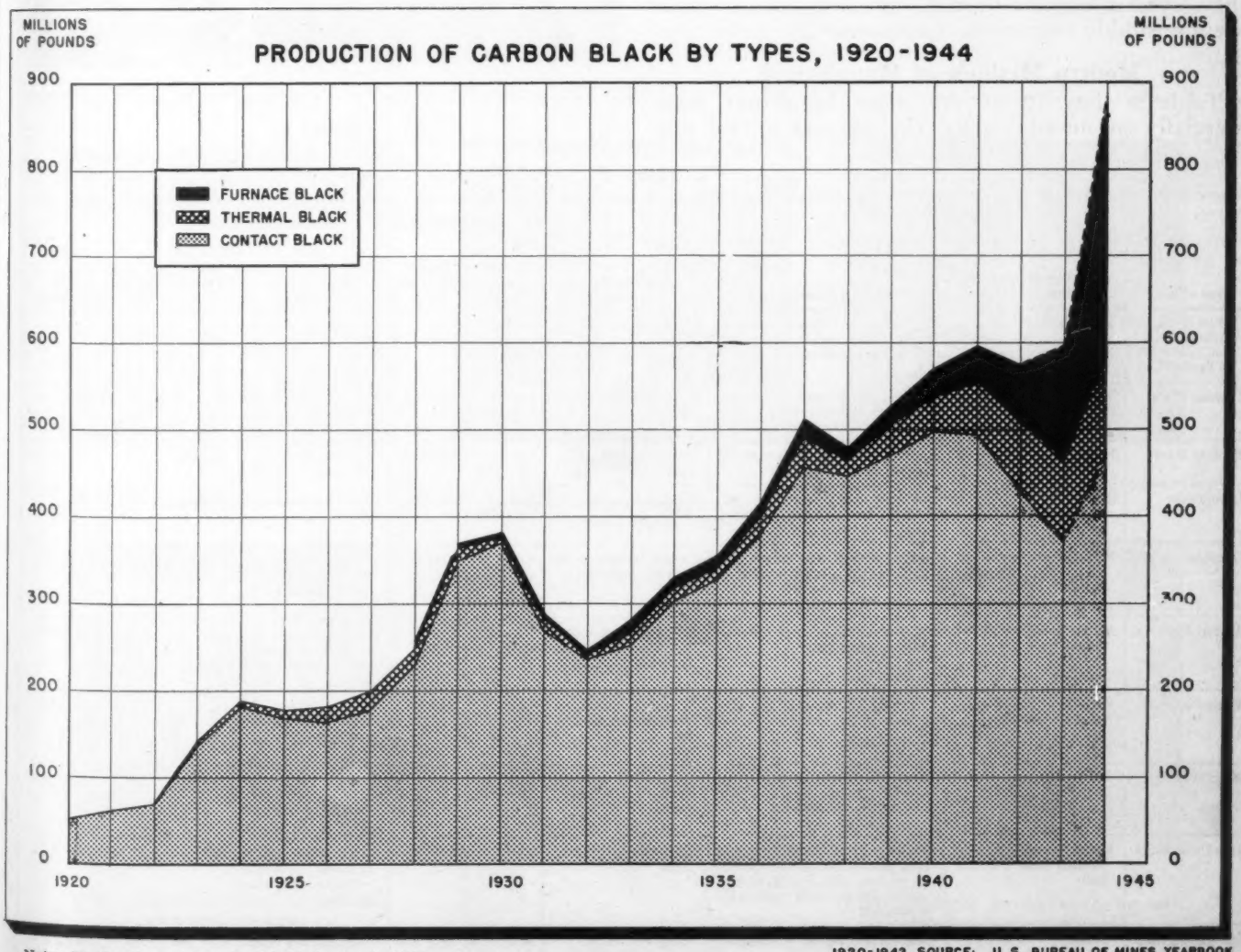
In 1884, Godfrey L. Cabot, working for his brother Samuel at Worthington, Pennsylvania, received a patent on the use of stationary plates and revolving scrapers, a modification of Martin's system. Three years later, when the annual production of carbon black had reached the then staggering total of one million pounds, he bought the business from his brother and founded Godfrey L. Cabot, Inc., one of today's largest manufacturers of carbon black. By 1892, when L. J. McNutt patented the channel process which has since dominated the field, the price of carbon black—continuing its steady decline—was down to 6 cents per pound.

The process invented by McNutt has, in the past 50 years, gradually displaced other contact manufacturing methods, with insignificent exceptions. In 1900, only one fifth of the total production of 6-7 million pounds was made on such reciprocating channels, the rotating disc type still being predominant. In that year, and for 14 years to come, the Cabot plant at Grantsville, West Virginia, using stationary plates and rotating scrapers, was the largest single producer, averaging 10,000 pounds per day. from 1900 to 1915, during which period total annual production increased to 20 million pounds per year, there was a gradual exodus from Pennsylvania to the more prolific producing fields of West Virginia.

In 1913, Gustave Fernekes patented a method for the production of carbon black through thermal decomposition of gas in an electrically heated chamber. This method was never used commercially, but in 1916, Brownlee and Uhlinger patented a process in which the gas was brought into contact with highly heated refractory material, decomposing it into carbon and hydrogen. This formed the basic patent for the production of thermal type blacks, and a plant began operation in 1922 in Louisiana. Yields from the process have since ranged from 6 to 9 pounds per thousand cubic feet of gas, according to United States Bureau of Mines' statistics.[5]

Furnace blacks, lying between contact and coarser thermal carbons in the carbon-black spectrum, provided the next addition to the family of colloidal carbons. The Bureau of Mines first records production from furnace-type plants in 1928, when Louisiana and Texas each had one plant operating. Yields from this method are similarly high, ranging from 3 to 14 pounds per thousand cubic feet of gas. However, blacks obtained in the furnace and thermatomic processes have properties varying widely from those of contact blacks and, incidentally, of one another.

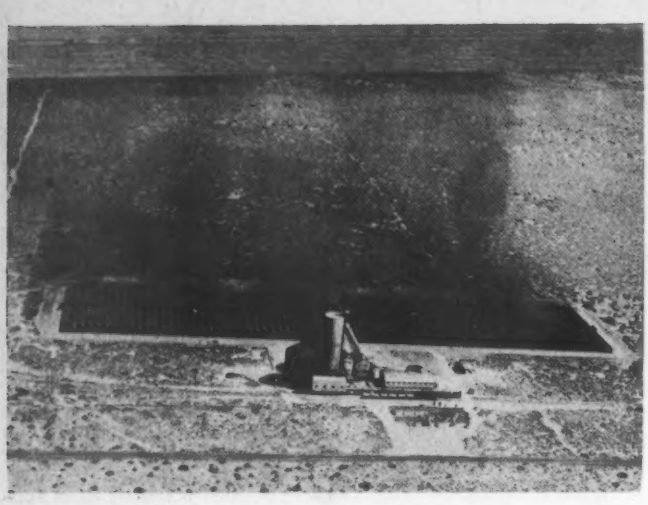
A twelve-fold expansion of carbon-black production took place between 1920 and 1941, as shown in Figure 2, with major expansion taking place in con-



Note: Production of furnace black began in 1927.

1920-1942 SOURCE: U S BUREAU OF MINES YEARBOOK
1943-1944 SOURCE: WAR PRODUCTION BOARD ESTIMATES

FIGURE 2



Courtesy, Godfrey L. Cabot, Inc.

FIGURE 3

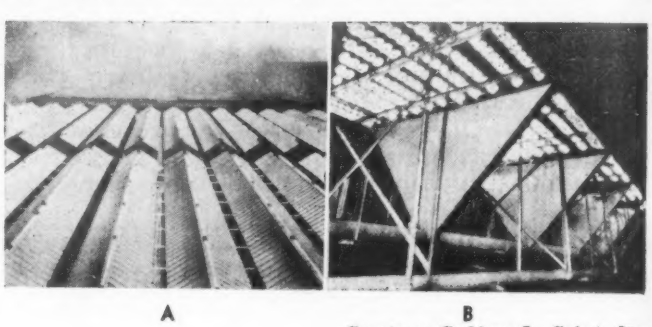
Channel black plant of Godfrey L. Cabot, Inc., Kermit, Texas

tact (principally channel) production. This was motivated principally by the discovery, about 1912, that carbon black served as more than just a pigment, in which capacity it was first used, in rubber tires. Only in the past two years, since America's supply of natural rubber was cut off by the Japanese, have thermal and furnace black production been greatly expanded as a corollary to the production program for synthetic rubber, in the compounding of which they exhibit certain over-all qualities which make them desirable over contact carbons.

Modern Methods of Manufacture

Table 1 lists 10 of the more important commercially produced blacks, the necessary raw materials and methods of manufacture, and the outstanding variations in physical properties. Of these blacks, the first three are by far the most important. The annual production of lampblack is now approximately 20 million pounds, with the production of gas blacks some 40 times as great. In the current year, production of these will be almost equally divided between channel or contact blacks, on the one hand, and furnace and thermal blacks, on the other. Of the latter two, furnace blacks will account for three-fourths of scheduled production of these types.

Figure 3 illustrates a modern channel black plant (that of Godfrey L. Cabot, Inc., at Kermit, Texas) which may be considered as representative of contact or impingement methods. Figure 4-A provides a closer view of the long burning houses (of which there may be 300 or more per plant), in which temperatures range from 400 to 1000° F., and Figure 4-B provides an interior view of one of the buildings in production. Each building houses some 1600 steatite (baked soapstone) burner tips, each of which is capable of producing about one ounce of carbon black per day from 40-50 cubic feet of gas. In the course



A B

Courtesy, Godfrey L. Cabot, Inc.

FIGURE 4

TABLE 1[10]

Type of Black	Basic Raw Material for Manufacture	Method of Manufacture	DIFFERENTIATING CHARACTERISTICS						
			Approximate Composition	Relative Color Index	Tinting Strength Index	Particle Size or Fineness	Relative Oil Absorption	Specific Gravity	Ash Content
Carbon Black (Colloidal Carbon)(GasBlack) (ChannelBlack)	Natural Gas	Impingement of flame against a cooler iron surface and scraping off carbon deposited.	Fixed carbon, 85 to 96%	Medium to very high	Very high	10 to 30 millimicrons (electron microscope)	Very high	1.7-1.8	Trace
Thermal Black	Natural gas, acetylene gas	Cracking gas by passing it through red-hot brick checkerwork or other methods with no combustion.	Fixed carbon, 95 to 99%	Low to medium	Medium	40 to 270 millimicrons (electron microscope)	Medium	1.8	Trace
Furnace Black	Natural gas	Burning natural gas in an enclosed system, using a free flame	Fixed carbon, 99% plus	Low to medium	Medium	75 to 90 millimicrons (electron microscope)	Medium	1.8	Trace
Lampblack	Oils	Burning oils in a free flame, collecting carbon thus produced away from flame	Fixed carbon, 80 to 95%	Low to medium	Medium	70 to 100 millimicrons (electron microscope)	Medium	1.76-1.8	Trace
Graphite	Mined, or made synthetically, using coal or other carbon	Heating coal or other carbon materials in the electric furnace	Carbon containing up to 25% impurities	Very low	Very low	Ground, fineness depending on requirements, usually 325 mesh	Very low	2.23	Up to 25%
Animal Black	Animal bones, i.e., steer, sheep, etc.	Charring animal bones in ovens or retorts	10 to 20% carbon plus volatile—remainder calcium phosphate	Very high	Low	Ground, fineness depending on requirements, usually 325 mesh	Low	2.2-2.6	80 to 90%
Vegetable Black	Plant life—wood, vines, process residues	Charring plant materials in retorts or ovens	50 to 90% carbon, remainder mineral matter	Low	Low	Ground, fineness depending on requirements, usually 325 mesh	Low	1.5	10 to 50%
Mineral Black	Carbon-bearing shale, coal, coke, slate, etc.	Mining the ore, cleaning, drying, calcining in some cases, grinding, sometimes air separating	Up to 85% carbon—remainder siliceous matter	Low to medium	Low	Ground, fineness depending on requirements, usually 325 mesh	Low	1.7-2.7	15 to 90%
Iron Oxide Black	Mined naturally or synthesized from iron and acid	Synthetically by dissolving iron in acid, precipitating ferrous hydroxide treating with air and steam to oxidize further until right color is obtained	Iron oxide or hydrated form	Low	Low	Mined oxide—coarse mesh size. Synthetic—500 to 1,000 millimicrons	Low	4.75-5.0	Iron oxide
Manganese Black	Mined	Cleaning ore, drying, grinding	Manganese dioxide	Low	Very low	Comparatively coarse	Very low	5.0	Manganese dioxide

of one hour, 24 of those burners will utilize the same amount of gas as the four top burners on an ordinary gas range, and will yield sufficient black for the printing of 60,000 newspaper pages, or 3750 16-page newspapers.

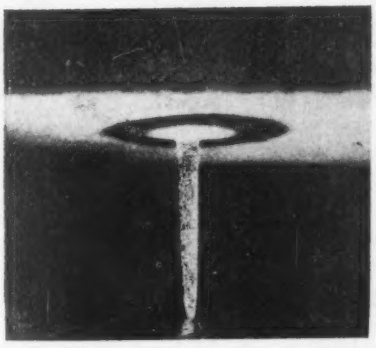
The fundamental principle involved in manufacture is illustrated in Figure 5-A. In effect the tiny flame is, within itself, a furnace. The outer surface of the flame at once serves as the furnace walls and, in burning completely admixed with air, raises the temperature sufficiently for decomposition of hydrocarbons in the inner airless chamber. The impinging surface, in this instance a steel channel, serves to collect the black quickly on a relatively cool surface, thereby at once preventing complete combustion or further alteration and agglomeration of the freed carbon particles. If the impinging surface were not provided as in Figure 5-B, the result would be that the carbon would be burned in the process of passing through the surrounding fiery walls, as evidenced in Figure 5-C.

The earliest type of flame used was just such a simple round flame, provided with an impingement surface. In the course of industry development, other flames have been tried and adopted, such as the fishtail type (Figure 5-D), similar to the acetylene burner once used in bicycle and automobile lamps, and the batwing type (Figure 5-E), which produces a flame similar to that formerly used for gas illumination.

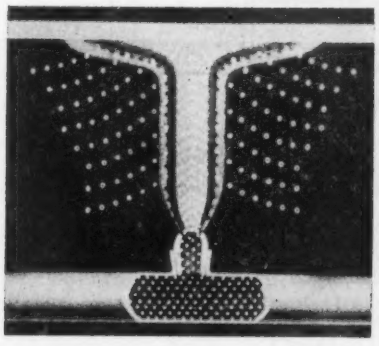
Wiegand[6] determined that the slotted burner tip was preferable for large-scale use, inasmuch as with a round flame the effect of any change in the rate of gas flow would be concentrated, rendering the flame highly sensitive; with a flat flame, such effect would be dispersed over the breadth and height of the flame, with consequent slighter change in the relatively more important height. His experiments indicated, however, that under ideal conditions a higher yield could be obtained with a tip having a round aperture. Figures 6-A and 6-B reveal the results of his small-scale tests, made with both round and flat flames, at constant gas flow and at fixed channel height, and indicate that, in general, round flames are affected by variations in these factors to a far greater extent than are flat flames. Although the effects of ventilation ordinarily provided in the burning houses —top and bottom drafting to compensate for day-to-day weather and month-to-month climatic variations —were not taken into account in these experiments, a general trend is definitely indicated.

A schematic representation of a channel-black plant is provided in Figure 7. After the black is deposited upon the reciprocating steel channels, it is removed by stationary scrapers and dropped through triangular hoppers to a screw conveyor. As it is scraped into the hoppers, it weighs only 3 pounds per cubic foot, and is 97 percent air. In the course of the journey to the packing house, the continual tossing and turning removes some of the occluded air. Blowing and screening in the packing house to eliminate grit continue the process until the contact black bulks about 13 pounds per cubic foot.

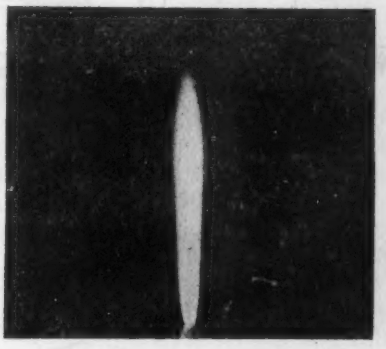
Carbon black was formerly sold in this form or, if desired, in semi-compressed (21 pounds per cubic foot) or heavy compressed (25 pounds per cubic foot) bags. However, the difficulty of compacting carbon black to either of these forms, coupled with



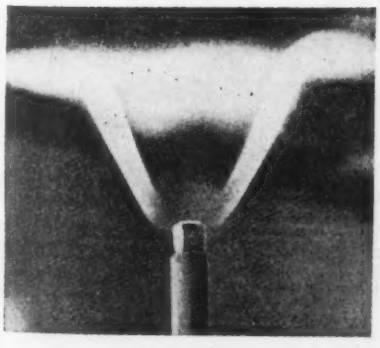
B
Impinged round flame.



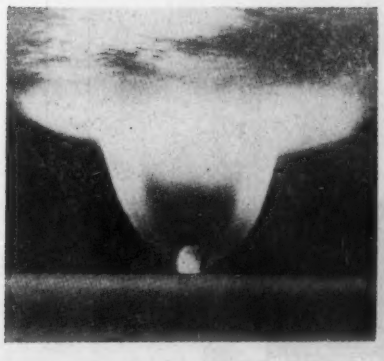
A
Diagrammatic representation of impinged carbon black flame.



C
Unimpinged round flame.



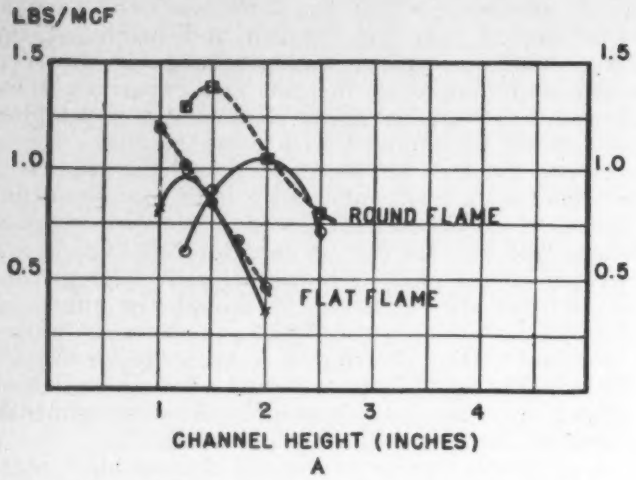
D
Flame produced by fishtail tip impinged upon steel channel.



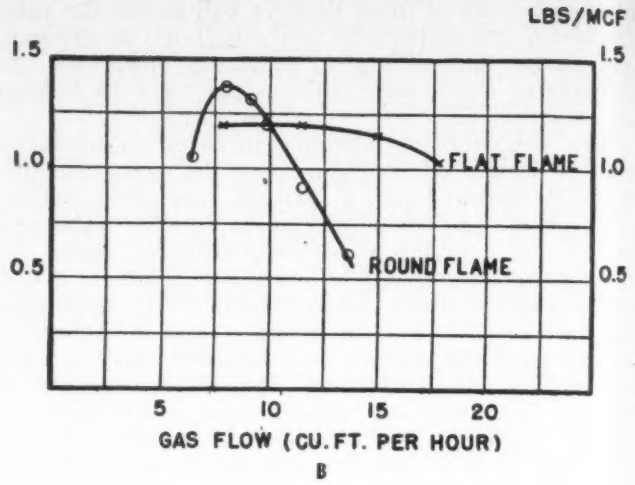
E
Flame produced by batwing tip impinged upon steel channel.

FIGURE 5

Courtesy, Godfrey L. Cabot, Inc.



Yield vs. channel height at constant gas flow. (Dotted line represents optimum yields with flow adjusted at each channel setting.)



Yield vs. gas flow at fixed channel height.

FIGURE 6

Courtesy, Industrial and Engineering Chemistry

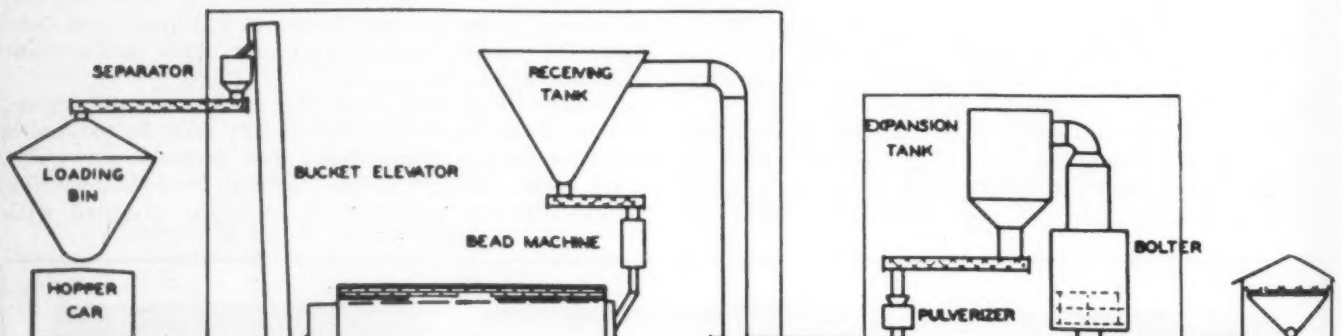


FIGURE 7

Courtesy, Rubber Age[18]

Diagrammatic representation of channel black process

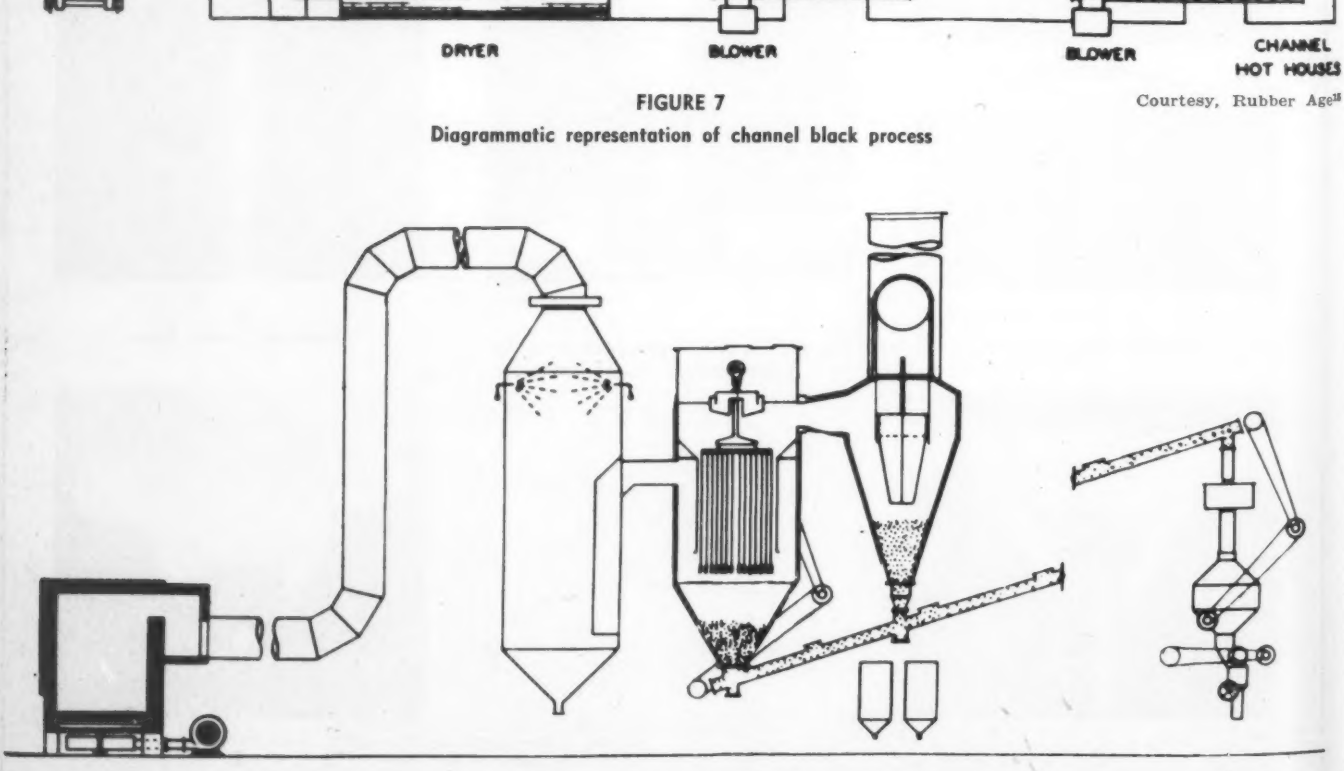
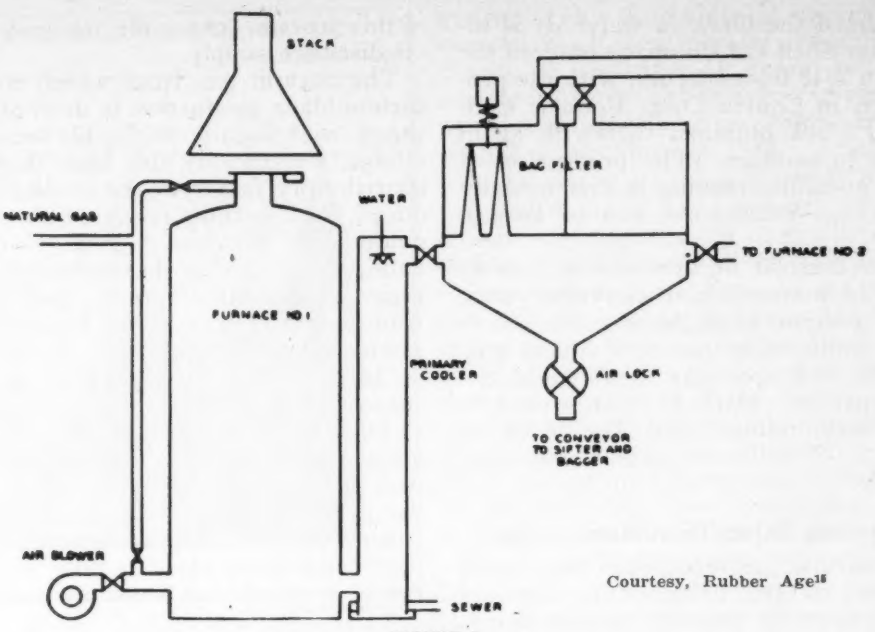


FIGURE 8

Courtesy, Rubber Age[18]

Diagrammatic representation of furnace black (Gastex) process.



Courtesy, Rubber Age[18]

FIGURE 9
Diagrammatic representation of thermal black process.

its subsequent resistance to dispersion, led manufacturers to experiment with other methods. As compaction lessened loss in packing, shipping, and compounding, and at once decreased shipping space requirements, it was definitely desirable. Experimentation accordingly was patterned to retain the desirable features of compaction and to eliminate those which were undesirable. In the 1930's, it was found that by agitation of the black in slurry form, small pellets or beads, each containing about a trillion of the dust-fine particles, could be formed without the use of binders which would resist dispersion. Various methods have been perfected for bead formation by the various manufacturers, and black is now sold principally in this form, bulking 27 pounds per cubic foot.

The furnace and thermal processes of manufacture are not too different fundamentally, as reference to the schematic diagrams of Figures 8 and 9 will reveal. Both make use of furnaces for the incomplete combustion or cracking of the raw material to carbon and hydrogen. Heat in the furnace process is provided by some of the gas introduced therein, as in contact processes. In the thermal process, on the other hand, heat is applied prior to entrance of the gas into the furnace, and straight cracking is involved. In each instance, the coarser, grayer black so obtained is carried on into a cooler, sprayed with water, and then collected by means of a Cottrell precipitator.

Figures 10 and 11 reveal, respectively, the furnace type plant of the General Atlas Carbon Division at Pampa, Texas, and the thermal type plant of Thermatomic Carbon Company at Sterlington, Louisiana. The thermal decomposition method was first employed in the production of hydrogen for ammonia, the carbon black providing a by-product. Commercial production of thermal black was begun in 1922 by Thermatomic Carbon Company, the plant being located in the Monroe field. Not until 1928 was the furnace process introduced, and plants then began operation in both Texas and Louisiana. Figure 8 illustrates the Gastex (Texas) process, which made use of a special furnace and burners. The Furnex (originally Fumonex) process, introduced in Louisiana, used large flames in a different type of furnace,

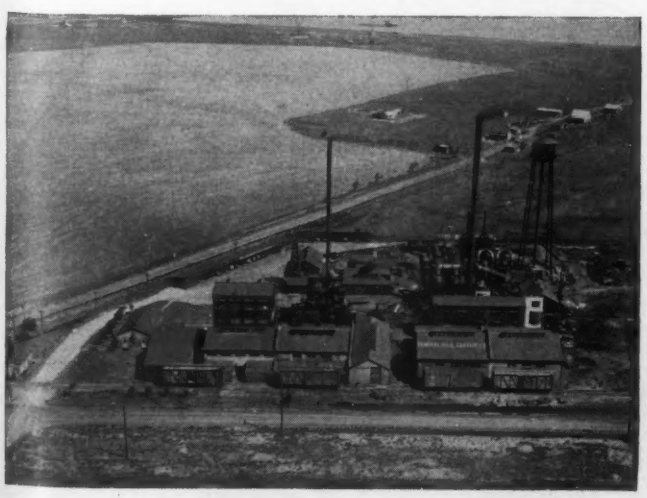


FIGURE 10
Furnace black plant of the General Atlas Carbon Division, Pampa, Texas.

FIGURE 11
Thermal black plant of the Thermatomic Carbon Company, Sterlington, Louisiana.

and originally collected the black in water. It is interesting to note that Shell Oil Company entered the carbon black field in 1942 in connection with the production of hydrogen in Contra Costa County, California, the thermal black obtained therewith again being essentially a by-product. (The production of hydrogen alone by pyrolitic cracking is commercially feasible even with gas rates some ten or twenty times higher.)

A variant of the thermal decomposition process was developed by Thermatomic in more recent years, whereby a smaller particle black having distinctive qualities has been produced by use of a diluent gas. In this instance the hydrogen gas obtained in the production of thermatomic black is reintroduced in the furnace along with natural gas. The black so produced appears as "P-33" on charts found elsewhere in this article.

Use of Raw Materials Other Than Natural Gas

Ultimate proven natural gas reserves in the United States are estimated at 180 trillion cubic feet, of which 110 trillion—over 60 percent—remain below ground today. By reason of her plentiful endowment and early exploitation of these reserves, America has long had a virtual monopoly on the production of carbon black, and exports have run second only to domestic use in the rubber industry (principally in tire compounding). However, attempts abroad to develop a suitable substitute as a self-sufficiency measure have been fairly well matched here at home as a conservation measure.

As noted earlier, artificial gas was used even before natural gas, but such use was not economically feasible. While this has held true for most other materials, it has been shown that some are suitable for carbon-black production. At least one type—acetylene black—has been in commercial production for some time past. In the pre-war years its production ranged from 5 to 10 million pounds per year; with supplies of gas black no longer reaching many foreign countries from the United States, production is now probably greater.

Acetylene black, much of which is now being made in Canada, may be produced by four processes, two of them—channel and thermic—similar to the corresponding carbon-black manufacturing methods.[7] In addition, acetylene may be decomposed under a pressure of 2 atmospheres when electrically sparked, and small quantities are also obtained as a by-product in the electric arc production of acetylene from methane. While acetylene black has a higher production cost, a higher price may likewise be asked, inasmuch as there are some unique qualities: high absorptive power and low resistance, for instance, render it excellent for use in dry cells.

Much of the experimentation which has been carried on has had as its primary purpose an increase in yield. While yields have been obtained as high as 40 percent of theoretical, the blacks so produced have been, in the main, of decidedly inferior quality. However, Jakosky[8], in his investigation of electrical processes of manufacture, found that satisfactory products could be obtained using kerosine, gasoil, gasoline, naphtha, benzol, creosote, alcohol, pine-tar oil, fuel oil, and transformer oil, and estimated that such production would cost slightly over 10 cents per pound. Where oil was used, ethylene and propylene were among the by-products, as was gas. Sale of these could, he suggested, further decrease the cost. There were, however, two prerequisites to the success of this process—cheap electric power and cheap light-oil distillate supply.

The natural gas from which the bulk of today's carbon-black production is derived is essentially methane, with usually negligible secondary amounts of ethane. Presumably this high degree of purity is a contributory factor to the quality of the blacks produced, for it permits ready adjustment of combustion equipment. Mixtures such as fuel oil, on the other hand, have variable decomposition temperatures for their component fractions, and are therefore less readily controllable. While experimentation has been carried on with other fuels along the lines followed by Jakosky, they have not heretofore been altogether successful. It is interesting to note, therefore, that Phillips Petroleum Company is now beginning commercial production of a black developed during the past six years which makes use of degraded oil as the principal base stock, consuming relatively little natural gas. The black produced is a medium loading—reinforcing black, a type which is now finding use in synthetic rubber compounding.

An attempt was made to secure a flow diagram and detailed information on the Phillips process for use in this article. While this material was not obtained, a letter relative to the product was received from A. H. Damon of Phillips Petroleum Company, and we have taken the liberty of quoting the following paragraph:

We wish to advise that our process has been placed under Secrecy Orders by the Commissioner of Patents, which deters us from discussing or writing about the process itself. However, the product we are producing is finding great interest in the rubber industry because of the exceptional processing properties it imparts to GRS, coupled with high reinforcement and low hysteresis. It approaches channel black in reinforcement and the semi-reinforcing furnace

TABLE 2

PARTIAL LIST OF CARBON BLACK USES[10]

Electrical Industry
- Arc electrodes
- Battery plates
- Brushes & electrodes
- Radio tubes
- Resistors

Inks
- Book and magazine inks
- Carbon paper
- Carbon inks
- Chinese stick ink
- Engraving inks
- Finger-print inks
- India inks; drawing inks
- Job inks of all sorts
- Lithographing, offset, half-tone inks
- Metallic black ink
- News ink
- Rotogravure
- Rotary stencil, duplicating, mimeographing inks
- Photogravure
- Quick-set inks
- Stamp-pad inks
- Tattoo ink
- Typewriter ribbons

Paints and Lacquers
- Airdry enamels
- All types of lacquers
- Alkyd enamels
- Artists' colors
- Baking enamels
- House paints
- Industrial paints
- Oil colors
- Screen and sash paints, etc.

Paper
- Album
- Bag
- Cardboard, panelboard
- Coated
- Photographic
- Resin and latex impregnated paper and board
- Wallpaper

Plastics
- All types including transcription and phonograph records

Rubber
- Boots
- Footwear of all sorts
- Hose, pressure tubing, etc.
- Mechanical goods of all sorts
- Tires
- Tubes
- Wires and cables, etc.

Hard Rubber
- Batteries
- Earphones
- Imitation bone handles
- Instruments, etc.

Latex
- Latex compounding
- Paper impregnated (artifical leather)

Miscellaneous
- Blackboard stock
- Brake shoe composition
- Cement—gray cement, bricks, concrete, tile, pavements, magnesia and sulphur cements
- Coloring glass
- Crayons—colored chalk, finger paint, crayon, water paint, etc.
- Dusting sulfur and fungicides
- Explosives
- Fertilizers
- Flooring materials (rubber and linseed oil bases)
- Leather finishes
- Metallurgical uses — reducing agent; tungsten-carbide alloys, etc.
- Rayon-acetate, viscose, cuproammonium, etc.
- Shoe and stove polish
- Tire dressing

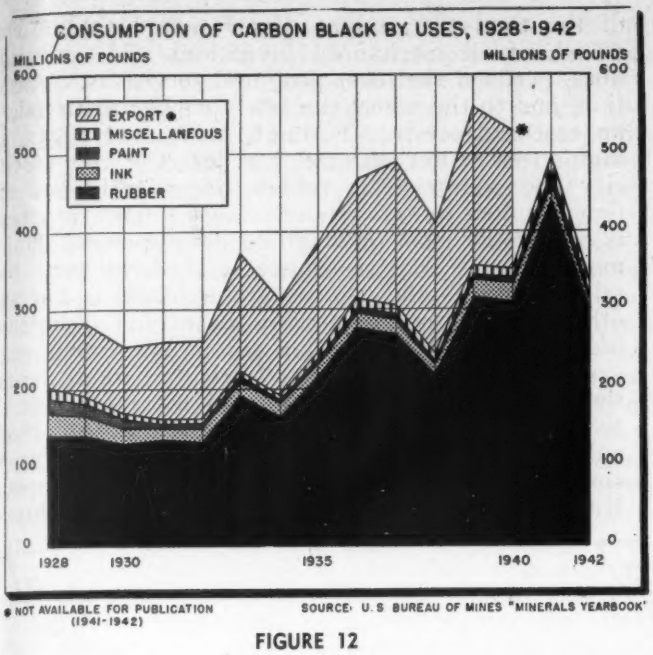


FIGURE 12

blacks in hysteresis, which appears to be a very desirable combination of properties not duplicable by mixtures of the two aforementioned blacks. Our yields are favorable with approximately 60 percent recovery from our conversion material as compared with about 3 percent recovery by the channel process.

Prior to World War I, zinc oxide played the role which has since been filled by carbon black. The rise in the price of zinc oxide which took place during the war lent impetus to the investigations which were then being made of carbon black in rubber compounding, although the start of these experiments pre-dated the outbreak of war. By 1920 the value of carbon black had been generally recognized throughout the tire industry. According to Fuchs[9], it was just two years later that Germany, with little in the way of natural gas and oil resources, began her search for a carbon-black substitute. In the course of the development of a suitable *ersatz*, experiments largely followed a pattern set by Berthelot in 1881, when he determined that acetylene could be disintegrated by explosion into carbon and hydrogen. By 1932, acceptable blacks were being produced by Wegelin and L. Mohr, the latter company's product reportedly so fine that it bulked 3:1 against American black. Unsaturated hydrocarbons such as olefins, diolefins (among them butadiene, important in the synthetic rubber program), acetylene and its homologs, anthracence, naphthalene, and gaseous unsaturates, are now being used for German black production. The German blacks are said to be comparable to the American in particle size and to impart equal tensile strength in rubber, and as the Czechoslovakians had developed a low-cost black prior to seizure by Germany, it seems probable that the comparison extends even into the economic field.

Important Properties and Uses of Carbon Black

Reference to Table 1 reveals that the four most important blacks—contact, furnace, thermal, and lampblack—vary in fixed carbon content from 80 to almost 100 percent, in relative color index from low to very high, in tinting strength from medium to very high, in particle size from 10 to 270 millimicrons, and in relative oil absorption from medium to very high, while there is also some variation in specific gravity. Table 2 provides an impressive listing of the uses to which these several properties are put, while Figure 12 indicates 15 years' growth in domestic consumption in categories covering rubber, ink, paint, and miscellaneous items. Export figures are available only through 1940.

In time of war it is particularly interesting to note the broad scope encompassed by the individually unique qualities of some 40 distinctive and necessary carbon blacks, blacks which find use in every phase of battle: behind the lines, in the paper work or orders affecting battle; in the communication of those orders to the front, in written form or by radio, telephone, or telegraph; and in their implementation in the machines of war. From the preparation for battle, involving reconnaissance photography and the translation of the data so obtained to carefully scaled maps, to the packaging and delivery of explosives to the front and their subsequent use against the enemy, carbon blacks play a multiplicity of roles.

Mattiello[10] has provided the following basic differences in composition of three type blacks derived through contact methods of manufacture:

TYPE	Percent Carbon	Percent Hydrogen	Percent Oxygen
Long Ink Black	92.6	.2	7.2
High Color Paint Black	95.9	.4	3.7
Rubber Black	96.4	.6	3.0

The development of contact carbons was coincident to the development of the high-speed rotary printing press in the third quarter of the last century. MacLeary[11] writes that:

> . . . Carbon black not only made the printed word more inviting to the eye, it also facilitated the production of printed matter at low cost and in great abundance. In this latter respect it served as an indispensable adjunct to the high-speed rotary press introduced in the 1880's—a press which would have failed completely had it not been for carbon black, since carbon black was the only pigment with the power to permeate and adequately color the fast-flowing, quick-drying news-ink which the high-speed rotary press required.

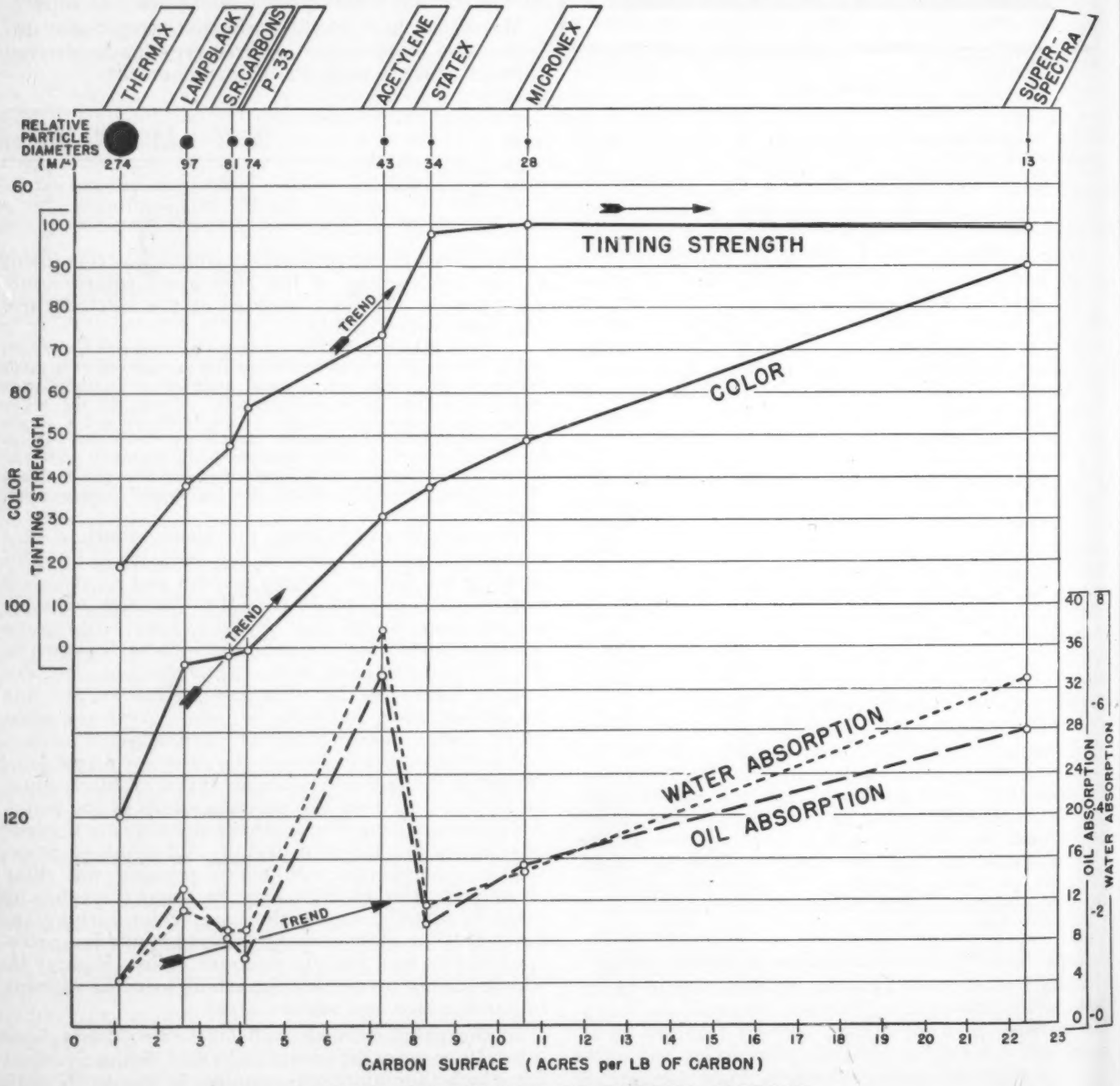
The easy flowing (long) ink blacks which played such an important part in the industrialization of printing are high in oxygen content and in absorbed impurities. They undoubtedly owe the valuable characteristic which they impart to inks—stringiness—to these occluded impurities, which act to prevent the carbon particles from agglomerating. Buttery (short) blacks, on the other hand, which are suitable for lithographic, halftone, or offset work, or slow press work, contain a higher percentage of carbon and correspondingly less of the other principal constituents. A minimum of nine types of black must be produced to meet the exacting needs of the printing industry—nine blacks possessing varying degrees of color value, speed of drying, and depth of penetration. Lampblack, with which printing was done altogether prior to 1864, may be some ten times as large in particle size as the finest color carbon, appears gray beside even ordinary grades, and has correspondingly less tinting strength. (See Figure 13, which relates properties important in color carbons to particle size and surface area).

In the paint, varnish, and lacquer industries, another 10 or more different blacks find distinctive uses for which they alone are suitable. It was to its high color intensity and resultant high hiding power that carbon black owed its adoption therein in the early days of the carbon-black industry; yet only in the

past 10 or 15 years, since the development of high-viscosity milling methods, has it been possible to take full advantage of these properties, which not only impart exceptional luster to the modern automobile finish, but also double its life. While the use of carbon black in these industries is old, it has, by virtue of the present superior methods of dispersion, been revitalized. Lampblack also finds extensive use in these related industries because of the bluish tinge and soft tone which it imparts to paints. Because of these particular properties, it is often used in conjunction with carbon black, which imparts excessive luster with an undesirable brownish undertone.

Less than 15 percent of annual domestic consumption enters into ink, paint, and the miscellaneous other items listed in Table 2, the balance being used in the rubber industry. While natural rubber was available, carbon black was used principally in tire tread compounding, and constituted about one sixth of the total tire weight. Geer[12] noted that: "The wheel, of all mechanical inventions, did, and still does, perform the most profound service to civilization, and to the wheel the lowly rubber tire renders an essential service. Through mud, over rocks, at high speed or low, through hot desert or cool forest, city and country, the rubber tire silently and efficiently does its task. Its resistance to abrasive wear is one of the most outstanding developments of the modern age." That resistance to abrasive wear, obtained through the use of carbon black, is but another of the great contributions of the petroleum industry to our present-day automobile economy.

According to Stillwagon,[13] British patents reveal that lampblack was used as a pigment as early as 1830. Later, in 1855, Goodyear noted that lampblack aided in immunizing rubber against the effects of sun and weather. It was not until after Diamond Rubber Company bought the United States rights to



SURFACE BEHAVIOR OF RUBBER CARBONS

FIGURE 13

Tinting strength, color and absorption vs. surface area (Adapted from Columbian colloidal carbons).

manufacture the Silvertown cord tire that carbon black was extensively used in tire compounding. The India Rubber, Gutta Percha and Telegraph Works Company, Ltd., of Silvertown, England, which developed the cord tire, wrote the American company at the time of sale (1912) that the use of 17½ percent by weight of carbon black in tread compounding provided a superior stock.

The first tires made by Diamond Rubber Company under the newly acquired patent rights made use of half white, half black treads, in order to test the findings of the English company. These experimental tires, in actual road tests, demonstrated that the black tread was not only longer wearing, but that it also held the road better. When Goodrich Tire & Rubber Company merged with Diamond, with the new company assuming the name of the former, the first full carload of carbon black ever sold to a tire manufacturer was ordered, and the black-tread tire was placed on the market. Strangely, although the investigation into its use in tire-tread compounding was initiated with a view toward finding a tread stock which would hold up as well as the cord, the quality stressed in early advertising was the ease of handling.

In 1914, Goodrich released the supplier, Binney and Smith, from secrecy on the newly developed use of carbon black. Other tire manufacturers, apprised of its use in rubber compounding, then began investigation, and during the World War, when the price of zinc oxide rose sharply, increased use began.

According to Seeds[14]:

"Beginning with the first use of crude rubber, and antedating the discovery of vulcanization, experiments have been made continuously to determine the effect of adding other materials to crude rubber, in order to change its properties. It is safe to say, that in the period from 1820 to 1920, an attempt was made to incorporate practically every known substance into a rubber mix. Out of this experimentation there has evolved a comparatively limited list of standard materials which are in common use today and on which our rubber chemists can agree in general as to the specific properties they impart to a rubber compound."

While it was recognized before 1920 that carbon black imparted certain special qualities to tire treads when used in their compounding, its addition to tread stock was handled in an altogether empirical fashion, with dosages varying from 3 to 20 percent. Another difficulty in clarifying the true value of carbon black lay in the fact that, as one source[15] has noted, "The concept of pigment reinforcement was not generally understood. Too much reliance was still placed on sulfur in the vulcanization reaction so that a considerable part of the reinforcement benefit was dissipated through degradation of the rubber."

Following 1920, however, intensive study of the properties of carbon black in rubber compounding was undertaken by both tire and carbon-black manufacturers, and thus began the evolution of the modern, long-wearing tire. Only then was it determined that the increased effectiveness of fillers accompanied decreased particle size. Then, too, it was shown that the addition of carbon black up to about 40 percent by weight gave reinforcing qualities roughly proportional to dosage. In more recent years it has been found that even higher dosages are possible, permitting very appreciable extension of the rubber supply.

In the course of much experimentation it has been proved that carbon black—chemically inert, yet physically active; easily "wet" by rubber, yet forming bonds between carbon and rubber equal in adhesive power to those existing in the rubber mix itself

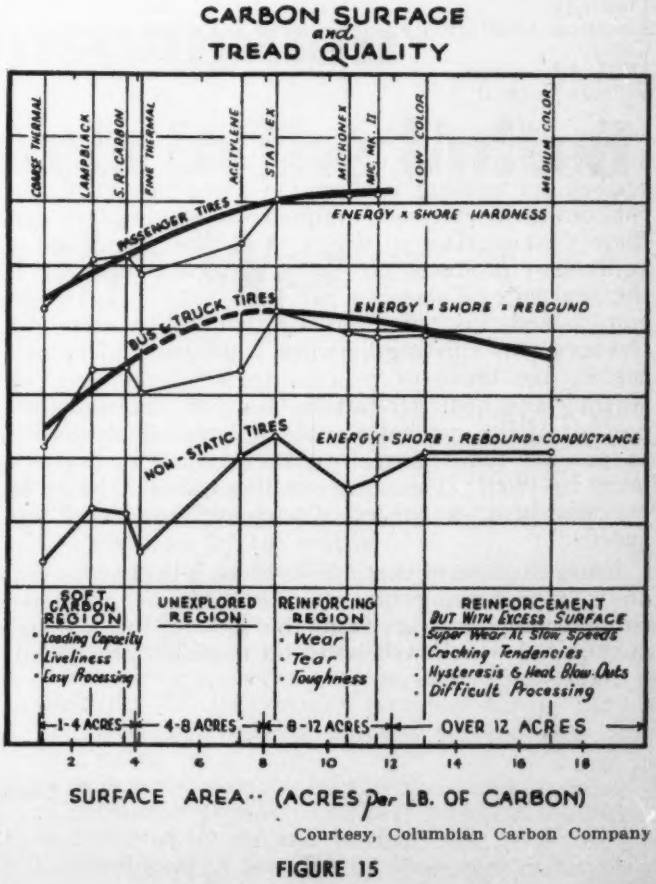
Courtesy, Godfrey L. Cabot, Inc.

FIGURE 14

Comparison of dispersion properties of three types of black in rubber compound.

—is the ideal filler. Optimum loading ranges have been established: for maximum toughness and liveliness, such as is required in solid rubber tires, up to 24 percent by weight; for maximum wear resistance and energy absorption, such as is required in tire treads and rubber footwear, from 24 to 65 percent; and for high modulus and stiffness, good tensile strength and elongation, and a leathery consistency, desirable in specialty rubber goods, even higher loadings have been used to advantage.

Although both thermal and furnace blacks were in production prior to 1930, their use in rubber compounding was greatly limited by their larger particle size. Figure 14 provides views of rubber compounds loaded with three basic type carbons produced from gaseous and liquid hydrocarbons, and it is notable that only the contact black appears to be smoothly



Courtesy, Columbian Carbon Company

FIGURE 15

and evenly dispersed. However, use of these coarser blacks has been greatly increased since the outbreak of war because of qualities not found in contact blacks. The finer-particle carbons provide maximum toughening and abrasive resistance. Furnace blacks, on the other hand, possess moderate reinforcing qualities, exhibit lower hysteresis, and are easier processing, and thermal blacks permit exceptionally high loading, while also effecting a nominal improvement of physical properties. Both are particularly useful as extenders. Figure 15 relates carbon surface and tread quality in the carbon-black family.

Within the representative ranges shown there are still other blacks, the individual importance of which has been accentuated by the prevalent higher loadings. Since publication of the foregoing chart, for instance, the Stat-ex family has been extended farther into the "reinforcing region" and has also been found to occupy an appreciable part of the so-called "unexplored region." Just as inks require some nine basic carbons for proper consistency, permeability, and drying power, so does the rubber industry find use for nine in the contact or channel group, because of variations in tensile strength, abrasive resistance, heat generation, and other qualities. Extremes in these properties are listed below for the smallest (Grade 1) and largest (Grade 9) diameter contact blacks adopted for use in rubber compounding.[16]

	Grade 1	Grade 9
Tensile	highest	lowest
Elongation	lowest	highest
Modulus	normal	normal
Hardness	highest	lowest
Resilience	lowest	highest
Hysteresis Loss	highest	lowest
Heat Generation	most	least
Abrasion Resistance	highest	lowest
Flex Cracking	most	least
Tear Resistance	highest	lowest
Plasticity	lowest	highest
Electrical Conductivity	highest	lowest
Color	blackest	grayest
DPG Adsorption	highest	lowest
Volatile Content	lowest	highest

The properties which carbon black conveys to synthetic rubber are not unlike those heretofore described for natural rubber. On the other hand, the rubbers themselves are unique from one another, and their distinctive qualities must be reconciled if equivalent products are to be obtained. Writing in the *Journal of Commerce* for June 3, 1943, I. Drogin emphasized this point, noting that: "The main differences now existing between synthetic and natural rubber are those of processing, reinforcement, resiliency and heat generation. Buna S, the most important of the synthetic rubbers, is relatively harder to process than natural rubber; it lacks reinforcement by itself; it is not as resilient, and it heats up excessively when subjected to heavy loads and high speeds."

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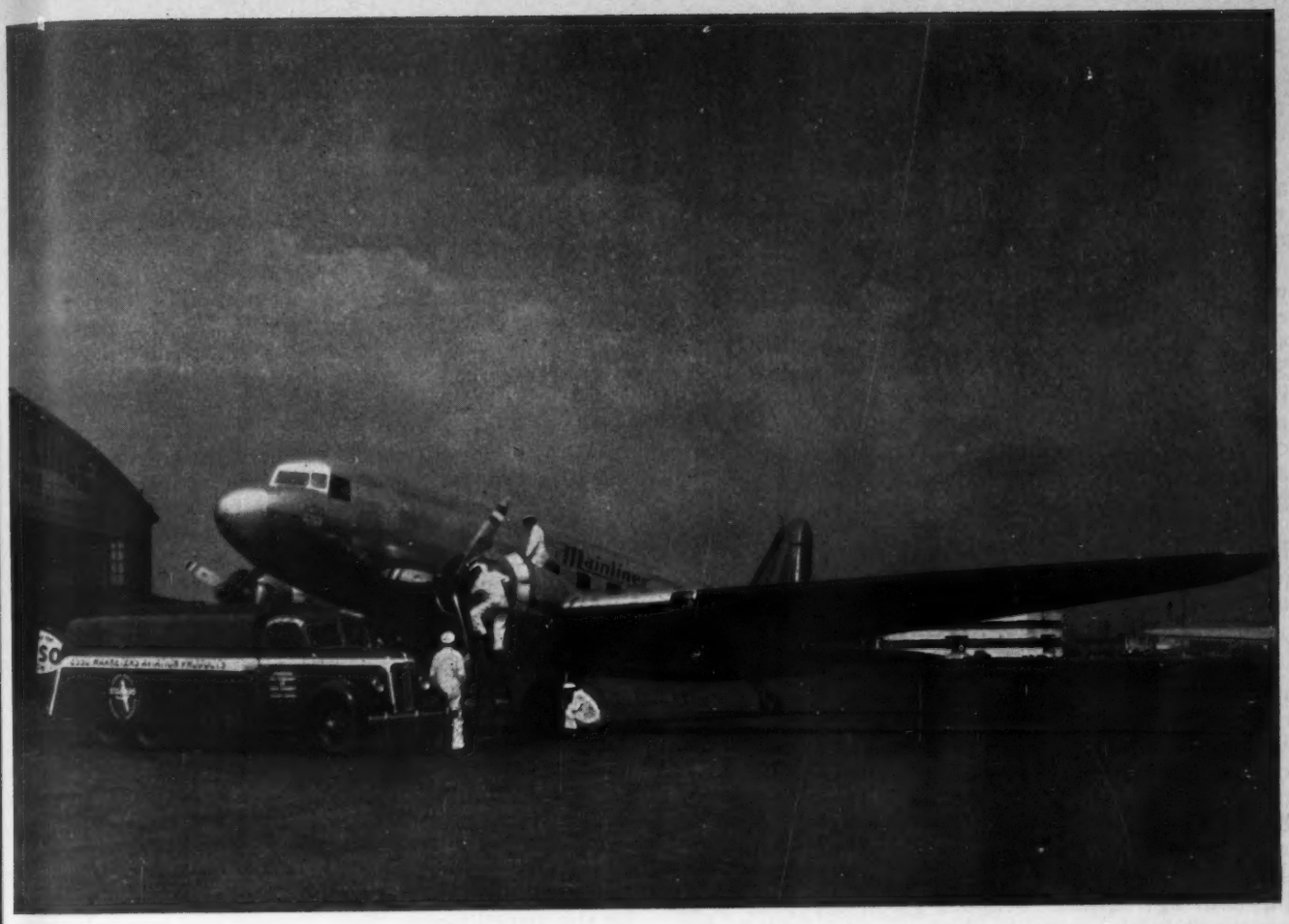

Estimated Consumption Of Petroleum Products in the United States After the War

IN MAKING this forecast of consumption of petroleum products through 1950, C. L. Burrill, Economics Department, Standard Oil Company of New Jersey, dealt with conditions as they are indicated from that period and drew assumptions. His complete paper was presented before the annual meeting of the American Institute of Mining and Metallurgical Engineers, New York, in February.

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1. The war will be over in Europe in 1944 and in the Far East by the end of 1945.
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4. Government control over the prices and qualities of petroleum products and over tanker rates will be removed by the end of 1945.
5. Consumption of gasoline by passenger cars will

and evenly dispersed. However, use of these coarser blacks has been greatly increased since the outbreak of war because of qualities not found in contact blacks. The finer-particle carbons provide maximum toughening and abrasive resistance. Furnace blacks, on the other hand, possess moderate reinforcing qualities, exhibit lower hysteresis, and are easier processing, and thermal blacks permit exceptionally high loading, while also effecting a nominal improvement of physical properties. Both are particularly useful as extenders. Figure 15 relates carbon surface and tread quality in the carbon-black family.

Within the representative ranges shown there are still other blacks, the individual importance of which has been accentuated by the prevalent higher loadings. Since publication of the foregoing chart, for instance, the Stat-ex family has been extended farther into the "reinforcing region" and has also been found to occupy an appreciable part of the so-called "unexplored region." Just as inks require some nine basic carbons for proper consistency, permeability, and drying power, so does the rubber industry find use for nine in the contact or channel group, because of variations in tensile strength, abrasive resistance, heat generation, and other qualities. Extremes in these properties are listed below for the smallest (Grade 1) and largest (Grade 9) diameter contact blacks adopted for use in rubber compounding.[16]

	Grade 1	Grade 9
Tensile	highest	lowest
Elongation	lowest	highest
Modulus	normal	normal
Hardness	highest	lowest
Resilience	lowest	highest
Hysteresis Loss	highest	lowest
Heat Generation	most	least
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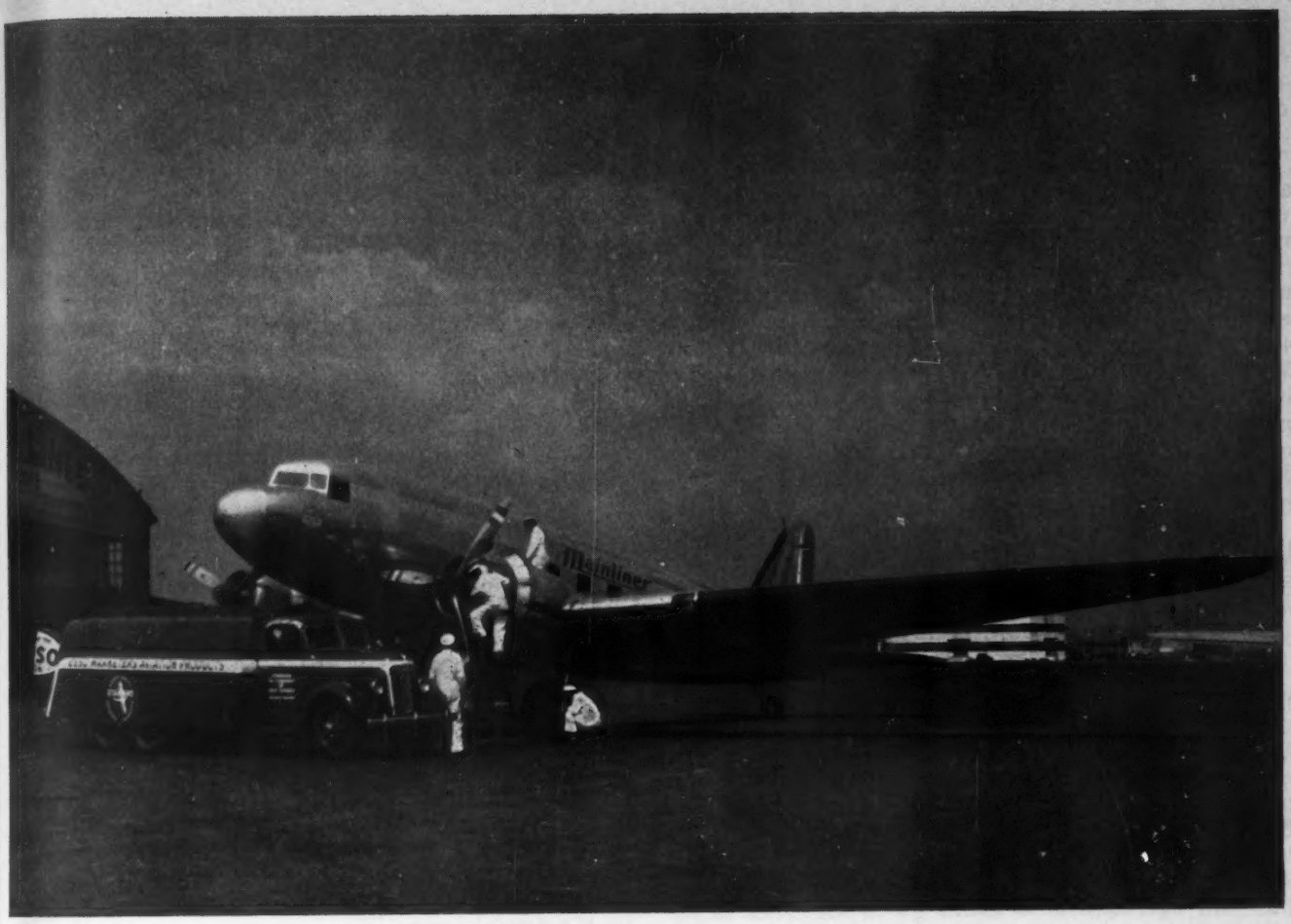

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5. Consumption of gasoline by passenger cars will

not be seriously limited by the availability or quality of tires after January 1, 1945.

6. Consumption of gasoline by trucks and busses will not be limited by the availability of tires after July 1, 1946.

The author recognizes the chances of error in his assumptions and discusses both favorable and unfavorable indications, and comes to the following estimate of consumption of gasoline over the period:

"Using the above estimates of passenger cars in use and consumption per car, the writer obtained estimates . . . which indicate a demand in 1946 of 402,000,000 barrels (9.5 percent less than in 1941) and 572,000,000 barrels in 1950 (28.5 percent greater than in 1941). The largest increase in any year over the previous year is estimated for 1947 when large increases in both the number of cars and the consumption per car combine to give an increase of 108,000,000 barrels, or 27 precent.

"Exports of automotive grade gasoline are expected by the writer to show a steady decline during the period as other areas become more economical sources of supply.

Truck and Bus Consumption

"The estimates of truck and bus consumption are not based upon an analysis similar to that just described for passengar car consumption, chiefly because the available facts upon which to base estimates are even less reliable for trucks than those available for passenger cars. Estimates of gasoline consumption by uses have been published infrequently in the past, and at best are estimates based upon rather small samples. The breakdown of passenger-car, truck and bus and agricultural demand given for 1941 is approximately the same as the estimate published by the Bureau of Public Roads. In making the estimates the writer tried to reflect the effect of high levels of business activity and the continued expansion of truck and bus transportation on the one hand, and the growth in the use of diesel engines on the other. While it is recognized that other factors may tend to reduce consumption per unit, it is not believed these will have an important effect during this period. Therefore, the writer believes that the estimates of truck and bus consumption shown are, if anything, conservatively low. A rough check obtained by dividing the estimates of consumption by estimates of the average number of trucks in use indicates a slowly declining consumption per average truck from 1946 to 1950.

Agricultural Consumption

"During the war agricultural income has increased greatly over prewar levels. Farmers have reduced their debts substantially, and there has been considerably less speculation in farm lands than there was during the last war. As a result, farm savings have increased to the highest levels in history. In view of this fact and the prospect that business activity will be high, it is reasonable to expect that farmers will have the financial ability to purchase larger than normal quantities of mechanical equipment. Since gasoline-consuming equipment will constitute a part of these purchases, agricultural consumption of gasoline has been increased from 25,000,000 barrels in 1941 to 30,000,000 barrels in the postwar years.

Aviation Gasoline Consumption

"There is little information available upon which to base estimates of aviation-gasoline consumption since statistics of production and stocks were shown separately by the Bureau of Mines for only a short period before the war. These meager statistics indicate that prewar consumption was very small as compared with that estimated at present, and a large reduction in demand is to be expected, therefore, even though postwar consumption is several times the prewar rate. The writer's estimates may appear low to many people in view of the optimistic statements which have been published about postwar aviation. The comparison of 17,000,000 barrels in 1946 and 12,756,000 barrels in 1941 is probably misleading, however, because in 1941 estimated governmental consumption was 5,600,000 barrels, which was three times the amount used in 1940, and four and one half times that consumed by the government in 1939. Also, in 1941, approximately 3,000,000 barrels were used for training purposes in addition to the amounts used for that purpose which might be included in the governmental figure. It is estimated, further, that approximately 1,000,000 barrels were consumed in testing engines. Only 2,500,000 barrels of the 1941 total domestic consumption, therefore, can be attributed to civilian uses. Scheduled airlines used approximately 2,000,000 barrels, and private flying accounted for only 500,000 barrels in 1941. The 1946 estimate of 17,000,000 barrels, therefore, would allow for a consumption by scheduled airlines of three times the 1941 rate, four times the consumption by private flyers in 1941, and still leave 9,000,000 barrels for engine builders, for training, and for other military use. Because of the large number of pilots available in 1946 there should be very little consumption for training purposes. Also, engine builders will probably use very little, so that the entire 9,000,000 barrels can be used by the armed forces. This is seven and one half times the amount used for that purpose in 1939.

"The estimate for 1947 is held at the 1946 figure because the writer expects that military consumption will decline while civilian consumption increases in equal amount. Beyond that year substantial annual increases are shown so that by 1950 consumption is estimated at 30,000,000 barrels. If 7,000,000 barrels of this is considered military consumption, the remainder would be nine times the 1941 consumption by scheduled airlines and private flyers.

"Estimates of aviation gasoline exports to Asia and Oceania are relatively high in 1946 and 1947, on the assumption that manufacturing facilities in the Near East and Far East will not be able completely to meet the demand in those areas until 1947. Also, it is expected that some military consumption will remain for a short period after the war in Asia is won. Exports to Asia are eliminated by 1949, but some exports to Oceania are retained to supply eastbound transport planes from Hawaii. Exports of aviation gasoline to Europe are increased over the period, chiefly to supply westbound transport planes from the United Kingdom. These estimates give a total demand for aviation gasoline of 29,500,000 barrels in 1946, 24,000,000 barrels in 1947, and 36,000,000 barrels in 1950.

Total Gasoline Demand

The estimates of total demand for all gasolines indicate a figure of 649,500,000 barrels in 1946, which is only 6.5 percent less than the prewar peak demand reached in 1941. A sharp increase, almost entirely attributable to passenger-car consumption, is indicated for 1947, and by the end of the period total demand is estimated at 862,500,000 barrels, which is 24 percent greater than it was in 1941.

Application of Unit Operations To Fractionation and Other Vaporization Processes

2. The Application of Phase Equilibria—Principles to the Behavior of Water-Hydrocarbon Systems

R. L. HUNTINGTON
School of Chemical Engineering
University of Oklahoma

ADOPTION of this series of articles as the basis for study, especially in vocational classes, is one of the possible uses for this fundamental data on condensation and fractionation. Study within refining personnel may be based on the articles.

In a previous series in 1941 several instances of these uses came about.

The author stressed the point in his first article, however, that the study of the papers will not take the place of class-room instruction in engineering.

He does feel, from his own experience in plants, that the articles will give the engineer and the plant operator an understanding of the physical laws governing the behavior of hydrocarbons and the quantitative method of attack in solving engineering problems pertaining to certain unit processes, in particular, vaporization.

IN A recent paper[2], several simple systems such as steam, water and inert gases were analyzed from the standpoint of the phase rule, since the steam boiler plays an important part in the operation of every refinery and gasoline plant. The Gibbs phase rule[1] can also serve as a useful tool in the study of equilibria between hydrocarbon vapors and liquids, a sound understanding of which is needed in the solution of problems pertaining to the design of absorption, distillation and fractionation equipment. The rule may be stated mathematically as follows:

$$F + P = C + 2$$

Where F = the number of degrees of freedom or variance, such as temperature, pressure and composition
P = the number of phases
C = the number of components or chemical compounds which go to make up the system.

Immiscible Liquids Water-Hydrocarbon System

1. Vapor Pressure or Bubble Point.

Since steam is used in the distillation of various hydrocarbons, it is well to consider the phase relationships of these components. Most hydrocarbons are only slightly miscible in water i. e., they dissolve to a very small extent. In the vapor phase, steam and hydrocarbons are readily mixed, although stratification may occur in the absence of convection currents provided the hydrocarbons have different densities than that of water vapor.

Let us consider a cylinder containing a gallon each of water and liquid pentane on which a frictionless piston is exerting a pressure of 16.95 pounds per square inch absolute or 2.25 pounds gage (based on atmospheric pressure of 14.7 pounds per square inch absolute). So long as the temperature of the cylinder is kept below 100° F., there will be no tendency for vapor to form, and the piston will lay on the surface of the liquid (Figure 1). To make a check up on the

state of the system, it is found by reference to the phase rule that the system is fixed since there are two liquid phases, two components (pentane and water) and two degrees of freedom have been fixed, namely temperature and pressure.

II. Vaporization of Pentane and Water at Constant Pressure.

As soon as the temperature is raised a differential amount above 100° F., the constant pressure piston is elevated due to the formation of vapor. Each component will exert its own vapor pressure independent of the other component. The pentane exerts a vapor pressure of 16 pounds per square inch absolute and the water 0.95 pounds, therefore the number of pentane molecules leaving the liquid as vapor will be 1600 compared to every 95 water molecules, or more accurately stated the ratio of pentane molecules to water molecules being transformed into vapor will be 16/0.95. In other words one must deal with extremely large numbers of molecules such as 6.06×10^{23} molecules for every gram molecular weight, which in the case of water is 18 grams or $\frac{18}{454} = .0397$ pounds. If a person could count the first few molecules which leave the pentane-water system, by means of a very high powered microscope, he might find variations from this ratio, however from the law of probability, this variation from the statistical average would rapidly approach zero as more and more vapor molecules are counted.

The piston will continue to rise as long as the temperature is held slightly above 100° F. until all of either the pentane or water (or both) disappear from the liquid state. In this case the initial quantity of each component is one gallon. One gallon of pentane at 60°F. is equal to 0.632 (sp. gr.)×8.33 (5.27 pounds) or 5.27/72 = 0.733 pound molecular weights (pound mols), as pentane has a molecular weight of 72. One gallon of water = 8.33 pounds or 8.33/18 = .4625 pound mols. Since 16 pound mols of pentane will vaporize while 0.95 pound mols of water are also turning to vapor, there will be, in this case, only $\frac{0.95}{18} \times .0733 = .00386$ pound mols of water vapor formed. There will be (.4625-.00386) = 0.45864 pound mols of liquid water remaining in the cylinder or $0.45864 \times 18 = 8.25$ pounds of water when all of the pentane has vaporized. (Refer to Figure 2.)

The vapor space will now be filled with .0733 pound mols of pentane and .00386 pound mols of water vapor at 16.95 pounds per square inch absolute and 100° F. The combined pentane and water in the vapor (.07765 mols) will occupy.

$$\underbrace{.07716}_{\text{lb. mols}} \times \underbrace{\frac{380}{1}}_{\frac{\text{std. cu. ft.}}{\text{lb. mol}}} \times \underbrace{\frac{560}{520}}_{\text{abs. temp. correction}} \times \underbrace{\frac{14.7}{16.95}}_{\text{abs. pr. correction}} = 27.2 \text{ cu. ft.}$$

while 8.25 pounds of water will be remaining as liquid in the bottom of the cylinder. During the interval when pentane and water existed both in liquid and vapor form, the state of the system was fixed regardless of the relative quantities of each one present in the two phases. In other words 3 phases were present (2 liquid and 1 vapor); 2 components (pentane and water), therefore to fix the state of the system, it was necessary only to set one degree of freedom, namely the temperature or the pressure.

III. Complete Vaporization of the Water-Pentane Mixture.

In order to convert all of the water into steam it will be necessary either to increase the temperature or to decrease the pressure.

(a) At Constant Pressure:

If the pressure is held constant, the temperature will have to be increased sufficiently to raise the vapor pressure of the water to that of the partial pressure of the water vapor. At the time all of the water has evaporated, there will be 0.0733 pounds mols of pentane and 0.4625 pound mols of water in the vapor space or 0.5358 pound mols of vapor. The total pres-

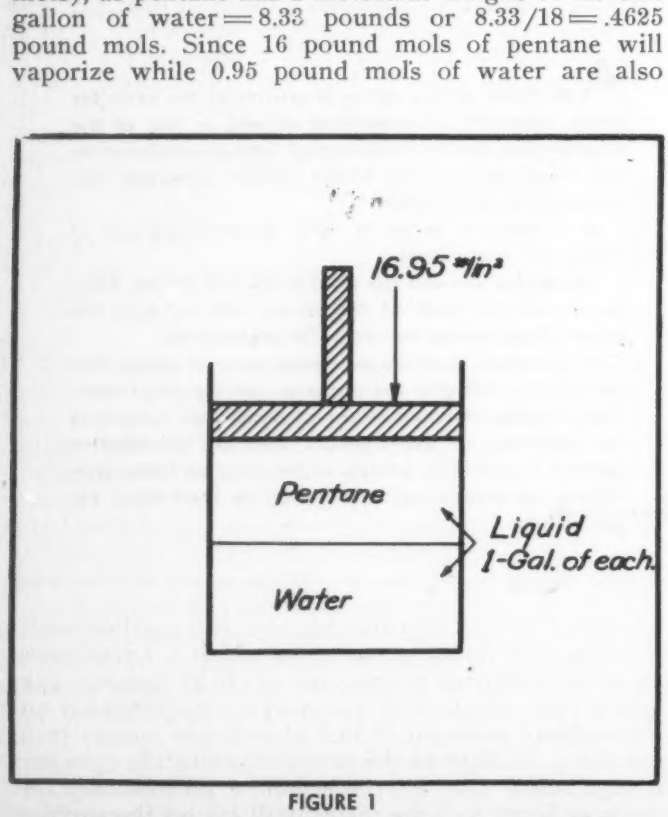

FIGURE 1
Liquid State. Temperature 100° F. or lower. Pressure = 16.95 lbs./sq. inch.

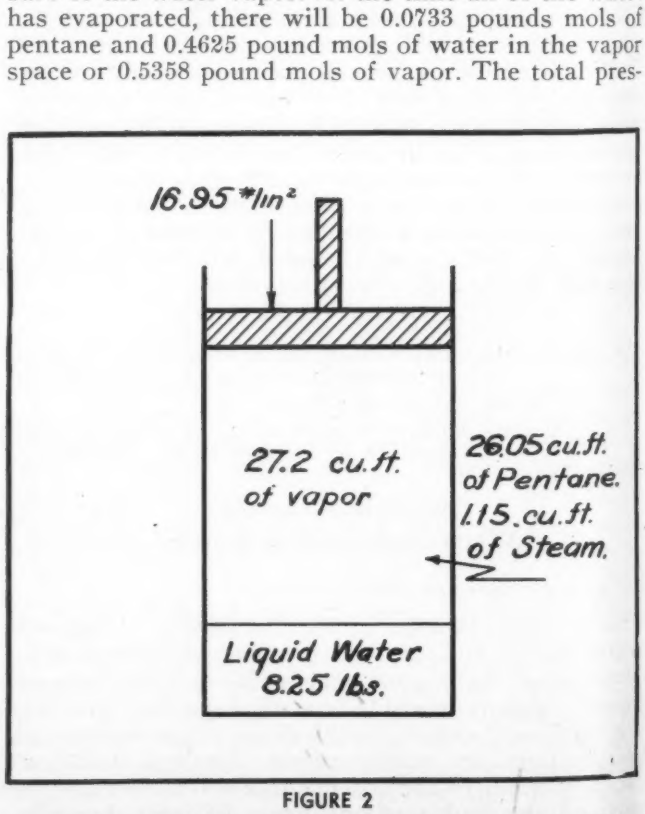

FIGURE 2
Complete vaporization of 1 gallon of n-pentane and partial vaporization of the water.

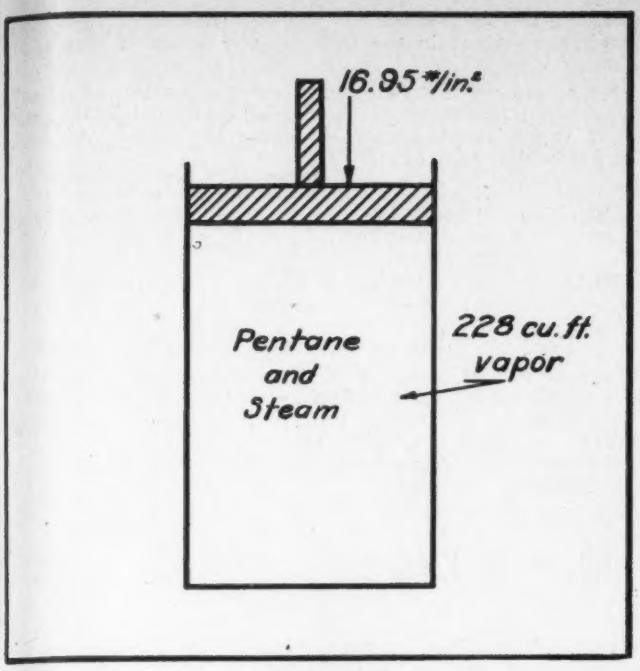

FIGURE 3

Complete vaporization of 8.33 pounds of water and 5.27 pounds of n-pentane at 16.95 pounds pressure and 211.8° F.

Partial pressure of steam.....14.63 pounds
Partial pressure of pentane..... 2.32 pounds

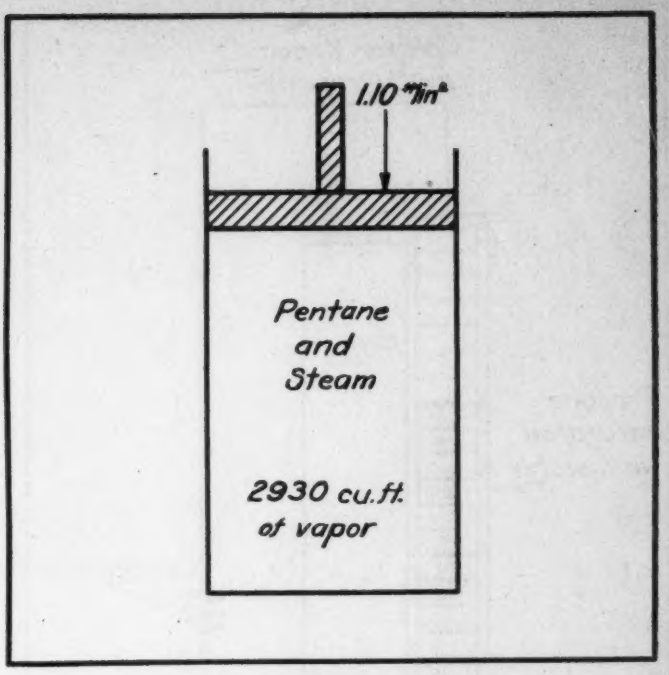

FIGURE 4

Complete vaporization of 8.33 pounds of water and 5.38 pounds of n-pentane at 1.10 pounds pressure and 100° F.

Partial pressure of steam.....0.95 pounds
Partial pressure of pentane.....0.15 pounds

sure is still 16.95 pounds and the partial pressures of the pentane vapor and steam are

$$\frac{.0733}{.5358} \times 16.95 = 2.32 \text{ lbs. and } \frac{.4625}{.5358} \times 16.95 = 14.63 \text{ pounds}$$

respectively. For the water to exert 14.63 pounds vapor pressure, a temperature of 211.8° F. is needed. (Figure 3.)

(b) At Constant Temperature:

If total vaporization is to take place at 100° F., the piston pressure will have to be reduced so that the partial pressure of the water vapor is kept at 0.95 pounds with all of the water evaporated. The steam will occupy

$$\frac{.4625 \text{ (mols steam)}}{.5358 \text{ (mols steam and pentane)}} \times 100 = 86.2\%$$

of the vapor volume and also exert 86.2 percent of the total pressure. Since the partial pressure of the steam is 0.95 pounds the total piston pressure will be $.95/.862 = 1.10$ pounds. (Figure 4.)

An Exception to the Rule: Dehydration of Propane

Water is slightly soluble in practically all hydrocarbons. In the fractionation of propane, a small amount of dissolved water is often found to be present. The removal of this water from the propane is required before it can be sold as domestic fuel as the presence of water is apt to cause freezing in the gas-reducing regulators. Drying agents such as silica gel have been used for the dehydration of propane, but the most satisfactory method of water removal has been effected through fractionation. Although propane has almost 200 times the vapor pressure of water, dissolved water in propane does not behave according to Raoult's law, but to the contrary, the dissolved water proves to be more volatile than the propane. As a result the water is taken out overhead from the fractionating column. (Figure 5.)

The following review exercises are suggested in the study of H_2O-hydrocarbon systems.

(1) In what volume ratio would normal hexane and H_2O have to be at 100° F. in order that the two components will condense simultaneously and at what absolute pressure would the mixture condense. Normal hexane and H_2O are immiscible as liquids.

(2) Five pounds each of H_2O and n heptane are distilled at a constant pressure of 14.7 lbs./sq. in. abs.

(a) At what temperature will the first vapor be evolved? What will be its mol composition?

(b) Which component will be the first to distill over completely and at what temperature?

(c) How many pounds of the other component will be left in the still at the time the first component is completely distilled overhead?

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APPENDIX

Selection of Exercises Which Appeared at the End of the Previous Paper of this Series

For the benefit of those readers who do not have this set of questions, the exercises are stated again, along with their solutions.

Statement

In each of the following cases determine what phase or phases would exist in a closed vessel or cylinder equipped with a frictionless piston at the stated pressures and temperatures. Also determine the volume or mol percent in each phase.

(1) H_2O only confined in a vessel at 212° F. and 16 lbs./sq. in. abs. Since the pressure is above the vapor pressure (or saturation pressure) at 212° F., the H_2O must exist as liquid water.

(2) H_2O only confined in a vessel at 212° F. and 10 lbs./sq./in. abs. Since the pressure is below the vapor pressure of H_2O at 212° F., the H_2O must exist as water vapor or superheated steam. The temperature corresponding to 10 lbs./sq. in. abs. is 193.21° F., therefore the steam has $212 - 193.21 = 18.79$° F. of superheat.

(3) A vessel containing 1 lb. each of nitrogen gas (mol. wt = 28) and H_2O (mol wt = 18) at 212° F. and 16 lbs./sq. in. abs.

Since the critical temperature of nitrogen is far below

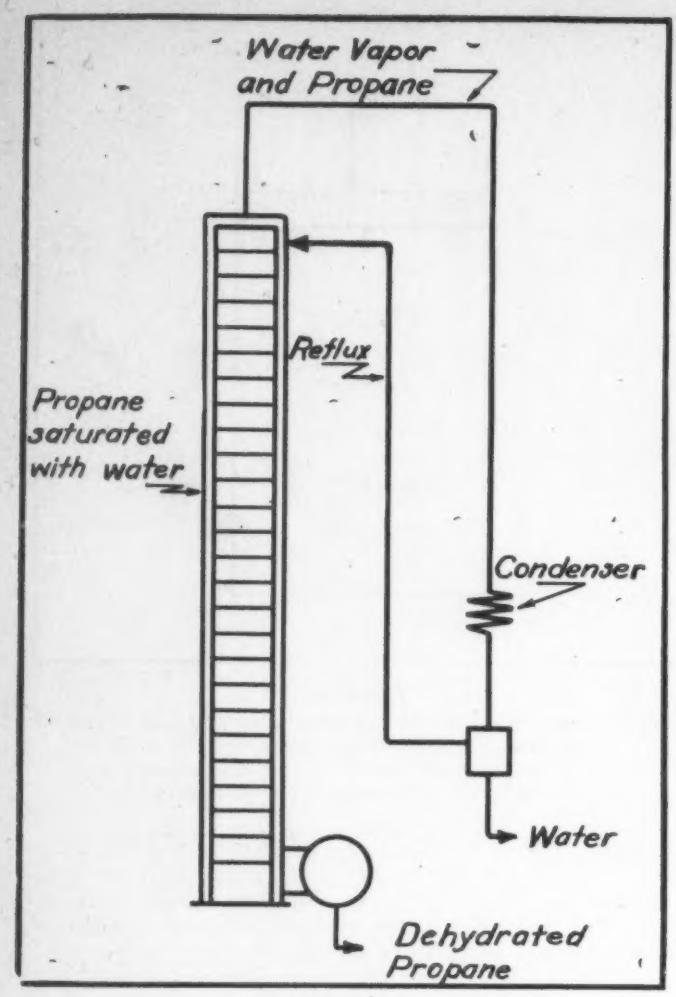


FIGURE 5
Dehydration of propane

zero, the nitrogen would be gaseous with substantially no nitrogen dissolved in the water if any water is present as liquid.

Let us assume that two phases exist, namely, a very small amount of liquid water and a gas consisting of nitrogen and water vapor. Neglecting the volume of water condensed, the gas will consist of:

	Mols	Mol or vol. %	partial pressure lbs./sq. in. absolute
Nitrogen	$\frac{1}{28} = .0356$	39	$.39 \times 16 = 6.25$
H_2O	$\frac{1}{18} = .0555$	61	$.61 \times 16 = 9.75$
Total	.0911	100	Total pr. = 16.00

Since the partial pressure of the water vapor is less than 14.7, no H_2O could exist as liquid under the stated conditions.

(4) A vessel containing 1 lb. each of nitrogen and H_2O at 212° F. and 40 lbs./sq. in. abs.

Assume, as in above case, that incipient condensation is taking place:

The gas phase consists of:

	Mols	Mol	Vol. %	Part. Pr.
Nitrogen	1/28 = .0356		39	.39 x 40 = 15.6
H_2O	1/18 = .0555		61	.61 x 40 = 24.4
				40.0

Water will condense out until its partial pressure of the water vapor falls to 14.7 lbs./sq. in. abs. The mols of water remaining in the gaseous phase will be $.0356 \times \left(\frac{14.7}{15.6}\right) =$ .0336 mols of H_2O. Water condensed will be $.0555 - .0336 = .0219$ mols or $.0219 \times 18 = .377$ lbs. or 37.7% of original amount of water present will have condensed.

(5) At what pressure would water start to condense out of a gaseous mixture consisting of 1 lb. each of nitrogen and H_2O confined in a vessel at 212° F.

	lbs.	Mols	Mol %	Partial Pr.
Nitrogen	1	1/28 = .0356	39	?
H_2O	1	1/18 = .0555	61	14.7

The partial pressure of nitrogen will be $39/61 \times 14.7 = 6.35$ lbs. per sq. in. abs. The total pressure would be $14.7 + 6.35 = 21.05$ lbs./sq. in. abs., the pressure at which water will start to condense out of the above gaseous mixture of nitrogen and H_2O at 212° F.

Study of the Effect of Catalytic Cracking on the Post-War Supply of Motor Gasolines, Distillates and Residual Fuels

INDICATIONS of the influence of catalytic cracking on motor fuel were given in the study of what has taken place in two areas, as outlined by W. G. Moore, Gulf Oil Corporation, and T. G. Elder, National Refining Company, before the annual meeting of the American Institute of Mining and Metallurgical Engineers, New York, February 24. Their comparisons are between actual operations in 1940 and projected operations with catalytic processes available.

Higher yields of gasoline, furnace oil and fuel gas are the general changes indicated, with consequent reductions in amounts of residual fuel oil. The accompanying tables show projected results.

For the "Study of the Effect of Catalytic Cracking on the Post-war Supply of Motor Gasolines and Distillate and Residual Fuels," the authors took the Eastern Seaboard and Gulf Coast refining centers as a group since these have had substantial additions of catalytic capacity, while the Mid-Continent has drawn limited catalytic cracking capacity.

The evaluations for these areas are given in the accompanying tabulations and the authors offered further explanations:

The quantities shown are from crude operations only, the blending of natural gasoline and processing of unfinished stocks having been eliminated from both the input and output.

It should be noted that the results shown under the caption, "1940 actual," sub-caption "Refiners with catalytic units now built or building," were obtained with non-catalytic cracking, as the amount of catalytic equipment operating in that year was negligible. The production of this group of refiners in 1940 is segregated only for comparison with the results given for the same group when operating under the alternatives shown.

The columns headed "All refiners" show the results after dilution by those refiners not now installing catalytic equipment.

The figures given in the tabulations must not be taken as a prediction of absolute results, but rather as indicating the direction and the possible extent of changes, since each of the three alternative operations evaluated is predicated on every refiner operating in the assumed manner, whereas, in fact, individual refiners will operate in different ways, depending upon many considerations peculiar to their particular situations.

PREVIOUS advances in refining technology have been slowly adopted with the result that influence on what the industry has to sell has been gradual.

Necessity for military-grade gasolines brought catalytic cracking into refining without regard to other considerations. Its capacity, the quality of its products, its ownership and its location, with the end of fighting, will suddenly become factors in what the industry has to sell.

This is only a digest of a study of this influence in future refining trends. With less crude oil, the area with substantial catalytic cracking capacity can provide more motor fuel and more distillates, at the expense of heavy fuels.

Comments

The figures given in the tabulation are too voluminous to comment on in detail, but the following general observations may be made.

The most important effect of the catalytic equipment installed is to greatly increase the flexibility of operation through increased cracking capacity and the peculiar features of catalytic cracking.

There will be a substantial increase in the amount of light products obtained from a barrel of crude, which may be taken either as gasoline or distillate fuel, and a substantial reduction in the amount of residual fuel oil made.

While the amount of residual fuel oil per barrel of crude will be less, the quantity of crude run will also determine the total supply. The figures given in this study relate only to the crude run in 1940, which was 3,555,000 barrels per day. Two other factors that would tend to reduce the fuel supply are (a) utilizing the heavier portions of the crude for charging to catalytic units and (b) further installations of catalytic units.

Gasolines of higher octane number will be made and the proportion of cracked to straight-run will increase.

The quantity of distillate fuel that can be made will be substantially greater, but there will be a material increase in the percentage of cracked furnace oil in fuels for household heating. This increase in the percentage of cracked material is favorable from the standpoint of the economical use of our petroleum re-

Comparison of 1940 Actual Refinery Production with Estimated Product Make from the Same Crude, Under Various Operating Conditions, Using the 1940 Non-Catalytic Cracking Plus Presently Authorized Catalytic Equipment

FOR THE MID-CONTINENT AREA

ITEM	1940 Actual Operations		(A) Maximum Gasoline Production After Making 1940 Volume of Furnace Oils		(B) Maximum Furnace Oil Production after Making 1940 Volume of Gasoline		(C) Crude Required for Making 1940 Volumes of Furnace Oils and Gasoline	
	WITH NEGLIGIBLE CATALYTIC CRACKING		WITH CATALYTIC CRACKING TO THE EXTENT OF SUITABLE STOCKS AVAILABLE FROM 1940 CRUDE RUNS					
	Refiners with Catalytic Units Now Built or Building	All Refiners	Refiners with Catalytic Units Now Built or Building	All Refiners	Refiners with Catalytic Units Now Built or Building	All Refiners	Refiners with Catalytic Units Now Built or Building	All Refiners
YIELDS								
Gasoline MB/Y	45,579	189,114	46,754	190,289	Same as 1940	Same as 1940	Same as 1940	Same as 1940
Percent Change over 1940	.....	.....	+2.6	+.6	.....	.....	.....	.....
Furnace Oil MB/Y	9,638	36,509	Same as 1940	Same as 1940	11,671	38,542	Same as 1940	Same as 1940
Percent Change over 1940	.....	.....	.....	.....	+21.1	+5.6	.....	.....
Residual Fuel Oil MB/Y	12,041	63,992	10,475	62,426	9,764	61,715	9,954	61,905
Percent Change over 1940	.....	.....	−13.0	−2.4	−18.9	−3.6	−17.3	−3.3
Fuel Gas MB/Y	6,366	21,911	6,413	21,958	6,182	21,727	6,363	21,908
Percent Change over 1940	.....	.....	+.7	+.2	−2.9	−.8	.....	.....
CRUDE REQUIRED MB/Y	84,876	359,924	Same as 1940	Same as 1940	Same as 1940	Same as 1940	82,966	358,014
Percent Change over 1940	.....	.....	.....	.....	.....	.....	−2.3	−.5
PRODUCT BLEND								
Gasoline								
Percent Straight Run	39.3	47.2	38.3	46.9	39.2	47.2	38.4	47.0
Percent Non-Catalytically Cracked	60.7	52.8	42.4	48.4	41.4	48.1	42.4	48.4
Percent Catalytically Cracked	.....	.....	19.3	4.7	19.4	4.7	19.2	4.6
Percent Total Cracked	60.7	52.8	61.7	53.1	60.8	52.8	61.6	53.0
Furnace Oil								
Percent Virgin	73.0	72.8	28.3	61.0	26.1	58.6	28.5	61.0
Percent Non-Catalytically Cracked	27.0	27.2	12.1	23.3	10.0	22.1	9.9	22.7
Percent Catalytically Cracked	.....	.....	59.6	15.7	63.9	19.3	61.6	16.3
Percent Total Cracked	27.0	27.2	71.7	39.0	73.9	41.4	71.5	39.0

NOTE—All figures represent net production from crude operations only, eliminating casinghead gasoline blended and charge from unfinished products, etc.

sources, but should receive attention from equipment manufacturers to insure that burners are properly adapted to its use.

There will be a reduction in the crude required for making a given demand of gasoline and distillate fuels, at the expense of residual fuel.

There will be an increase in the production of gas, but the butenes above vapor pressure requirements and possibly the propenes, will undoubtedly be utilized for the production of high-octane blending components for aviation and motor gasolines. The results of such operations are not reflected in the tabulations.

With increased cracking capacity, the tendency will probably be to use otherwise idle capacity for cracking stocks now in the reduced crude sold as fuel or vis-broken. This will reduce the volume of residual fuel, increase the production of gasoline and furnace oil from the same crude and reduce the crude required for a given volume of light products, over the figures shown in the tabulations.

With regard to the relative effect in the two areas covered in this study, it will be noted that the direction is the same, but the magnitude is greater for the East and Gulf coasts. This is due to two reasons: less catalytic cracking was installed in the Mid-Continent and refiners in this area made a greater percentage of gasoline, with less distillate and residual fuel, from their 1940 crude runs.

Comparison of 1940 Actual Refinery Production with Estimated Product Make from the Same Crude, Under Various Operating Conditions, Using the 1940 Non-Catalytic Cracking Plus Presently Authorized Catalytic Equipment

FOR THE EAST AND GULF COASTS AREA

ITEM	1940 Actual Operations		(A) Maximum Gasoline Production After Making 1940 Volume of Furnace Oils		(B) Maximum Furnace Oil Production after Making 1940 Volume of Gasoline		(C) Crude Required for Making 1940 Volumes of Furnace Oils and Gasoline	
	WITH NEGLIGIBLE CATALYTIC CRACKING		WITH CATALYTIC CRACKING TO THE EXTENT OF SUITABLE STOCKS AVAILABLE FROM 1940 CRUDE RUNS					
	Refiners with Catalytic Units Now Built or Building	All Refiners	Refiners with Catalytic Units Now Built or Building	All Refiners	Refiners with Catalytic Units Now Built or Building	All Refiners	Refiners with Catalytic Units Now Built or Building	All Refiners
YIELDS								
Gasoline MB/Y	188,329	251,834	201,855	265,360	Same as 1940	Same as 1940	Same as 1940	Same as 1940
Percent Change over 1940	.....	.....	+7.2	+5.4	.....	.....	.....	.....
Furnace Oil MB/Y	77,046	112,171	Same as 1940	Same as 1940	94,982	130,107	Same as 1940	Same as 1940
Percent Change over 1940	.....	.....	.....	.....	+23.3	+16.0	.....	.....
Residual Fuel Oil MB/Y	106,899	148,835	89,980	131,916	86,336	128,272	83,145	125,081
Percent Change over 1940	.....	.....	−15.8	−11.4	−19.2	−13.8	−22.2	−16.0
Fuel Gas MB/Y	24,450	30,616	29,634	35,800	26,977	33,143	27,556	33,722
Percent Change over 1940	.....	.....	+21.2	+16.9	+10.3	+8.3	+12.7	+10.1
CRUDE REQUIRED MB/Y	463,240	641,956	Same as 1940	Same as 1940	Same as 1940	Same as 1940	436,986	615,702
Percent Change over 1940	.....	.....	.....	.....	.....	.....	−5.7	−4.1
PRODUCT BLEND								
Gasoline								
Percent Straight Run	39.6	43.3	36.9	41.1	39.2	43.0	37.4	41.7
Percent Non-Catalytically Cracked	60.4	56.7	37.6	39.5	35.8	38.2	36.9	39.1
Percent Catalytically Cracked	.....	.....	25.5	19.4	25.0	18.8	25.7	19.2
Percent Total Cracked	60.4	56.7	63.1	58.9	60.8	57.0	62.6	58.3
Furnace Oil								
Percent Virgin	63.7	69.0	30.0	45.8	41.2	51.8	33.7	48.3
Percent Non-Catalytically Cracked	36.3	31.0	13.4	15.3	12.5	14.4	13.2	15.2
Percent Catalytically Cracked	.....	.....	56.6	38.9	46.3	33.8	53.1	36.5
Percent Total Cracked	36.3	31.0	70.0	54.2	58.8	48.2	66.3	51.7

Note—All figures represent net production from crude operations only, eliminating casinghead gasoline blended and charge from unfinished products, etc.

Bombs Fall on Ploesti

Here is a Liberator just above the chimney tops. The arrow points to damage. Note the blast walls around furnaces.

EFFECTIVENESS of the United States Air Force raid on the Ploesti, Roumania, refining center August 1, 1943, had its roots in preparations, aptly summed up by Lieutenant B. O. Lisle as:

"For the Ploesti mission every plant in each element was given a pinpoint and had to find it. There were no secondary targets."

His report of this raid and other bombings of oil installations in Europe was presented before the annual meeting of the American Institute of Mining and Metallurgical Engineers in New York February 17. Both the written report and pictures had been approved for presentation, which was made by Winthrop P. Haynes, Standard Oil Company of New Jersey.

Weeks of practice with a full-scale model of the refining installations built somewhere in North Africa helped the pilots and crews prepare for what has been described as the finest example of air blow against a petroleum target. The former manager of one of the plants gave assistance. Motion pictures made prior to the war were of value.

The Ploesti mission was singular in that high-altitude Liberator bombers were used for the low-altitude attack. The crews spent six weeks of mock attack all to the end that they could complete their actual attack in 90 seconds.

The result was that 50 percent of the refining capacity of the area was put out of commission for 90 days, while 25 percent was considered to have been out of service for six months.

The author gave the following summary of individual damage:

"Astra Romana, largest Ploesti refinery and important not only because it incorporates the one third of Roumania's cracking capacity but also because it is the central receiving station for oil from most of the other installations for transshipment by pipe line to the Danube for the barge haul to Germany, was severely damaged. The power house was put out of action, the cracking installation demolished, and almost half of its operational capacity destroyed. The modern Steaua Romana plant at Campina was wiped out as were large parts of the aviation-gasoline plant and other facilities of Creditul Minier, erected in 1942. Most of the vital units of the Columbia refinery, which had a considerable proportion of cracking equipment, were destroyed and its operational capacity cut in half, while half of the Phoenix Orion plant likewise was obliterated."

Contrary to popular opinion, refining equipment is not easily destroyed by bombing, especially its round vessels and chimneys. It is also easily protected by erection of walls. The report offered these details:

"It has been observed that apart from extensive use of camouflage materials to deceive pilots and bombardiers, employment of blast walls and revetments have been rather effective in reducing damage from aerial bombardment. Certain refinery units virtually enjoy an inherent immunity to the effects of blast and even a near-miss may cause only minor damage—whereas many industrial structures outside the oil

In the Columbia plant the damage is:

A. Toppled metal chimney.

B. Damaged overhead piping.

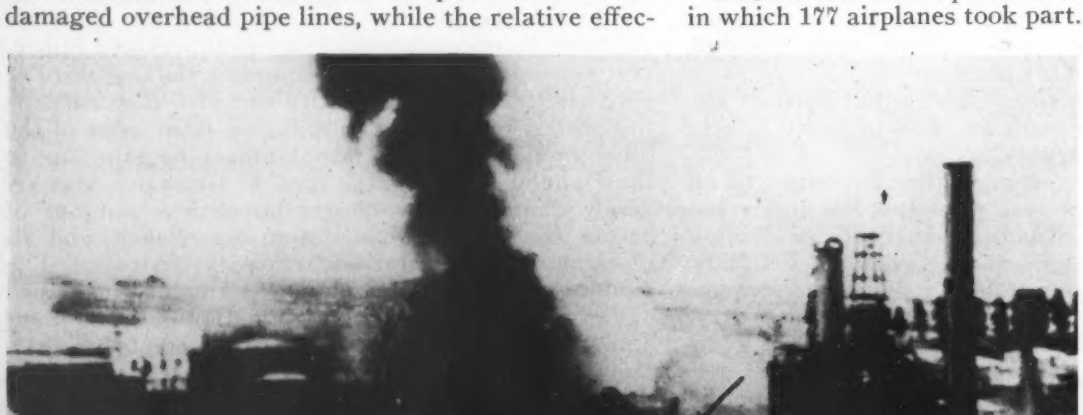
C. Blast wall proves effective in confining fire.

business are very vulnerable to concussion or blast. The circular cooling towers prevalent in Europe do not seem very susceptible to damage . . . . . .

"Likewise, since blast tends to flow around their curved surfaces, the tall brick refinery chimneys are rarely damaged except by a direct hit. A photograph taken during the Ploesti raid shows the top half of a brick chimney demolished. Another strike picture, showing a portion of the Columbia refinery, reveals that the metal chimneys may be toppled by a partial hit at the base. Near misses on the power house have damaged overhead pipe lines, while the relative effectiveness of the blast walls is helping to confine fires may be observed.

"On the other hand, broad flat surfaces, such as those of pipe stills, present considerable resistance to the impact of blast and the returning rush of air refilling the vacuum created by the explosion . . . Various pressure vessels and fractionating units probably enjoy the nearest approach to immunity, although a later picture, not available, shows evidence of considerable damage to the top of a refinery tower by a direct hit of H. E. probably a 1000-pounder . . ."

The Ploesti raid required total flying of 2400 miles, in which 177 airplanes took part.



A toppled column in the Creditul Minier plant is part of severe damage.

An Improved Meter For the Measurement of Gas Flow Rates

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Reprinted from Industrial and Engineering Chemistry, Analytical Edition.

IN THE study of reaction kinetics in flow systems, accurate measurement of the rate of flow of the intake and exit gases is essential. Flow-measuring instruments in common use are of two types: (A) meters that measure some function of the gas velocity—for example, the pressure drop across an orifice or the rate at which heat is conducted away from a heated wire—and (B) instruments that involve displacement of a liquid by the gas and continuous or discontinuous measurement of the volume displaced in unit time. The familiar wet-test meter is an example of this type. Both types of instruments, as commercially available, have disadvantages, particularly if flow rates of the order of 25 cc. per minute or smaller are to be measured. Type A requires a separate calibration curve for each kind of gas, hence is not suited for use with mixtures of unknown composition, such as the gaseous product of a thermal reaction. Type B requires estimation of and correction for the effect of the vapor pressure of the displaced liquid and for the solubility of some components of the mixture in the liquid. Meters of this type are therefore unsuitable for the measurement of intake rates.

The flowmeter shown diagrammatically in Figure 1 is an improved form of a meter described by Marsh[1] for measurement of very slow flow rates. The new type of meter is free from the disadvantages of the usual instruments in common use. The operation is clearly shown by the diagram.

Referring to the side view, gas enters at *A*, passes down the vertical tube, and forces a drop of mercury, *D*, to the right in the horizontal tube. Stopcocks S_1 and S_2 are open; S_3 is closed. When the drop reaches the end of the tube at *E*, the gas trapped behind the drop is discharged. However, as soon as the drop begins to flow into the 13-mm. bulb at *E*, the mercury level is pushed up at *C*, so that a new drop is forced into the horizontal tube, trapping a new segment of the gas stream. This drop then moves to the right and the cycle is repeated.

Thus, each cycle represents the flow of a definite volume of gas and the time between cycles is a measure of the flow rate. For low flow rates the time required for movement of the drop between two fixed points may be a more convenient measure of the rate.

Figure 2 shows a calibration curve obtained with hydrogen and with nitrogen, when gas volumes were measured by collection over water in suitable burets. The points for the gases are seen to fall accurately on the same line. The use of mercury as a displacement fluid eliminates the difficulties caused by use of water or organic liquids in the usual wet-test meters.

Some details of the construction and operation of the flowmeter need further discussion. The glass spirals permit adjustments in the tilt of the tube, which controls the size of the drop. Since there is a lag between the time at which the drop begins to flow into the bulb at *E* and the time at which the mercury rises at *C*, the drop must be of sufficient length to ensure that mercury will enter the horizontal tube at *C* before the drop at the right is entirely discharged from the tube. If this condition is

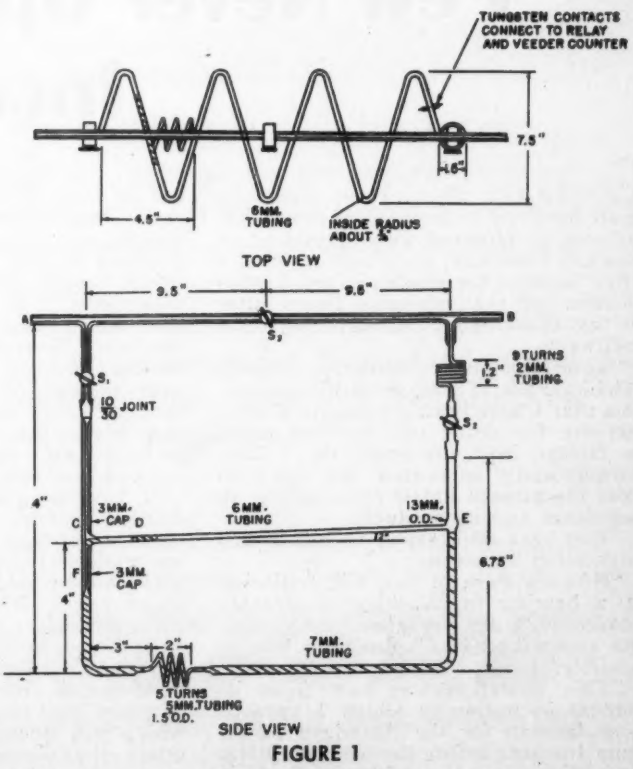

FIGURE 1
Diagram of Flowmeter.

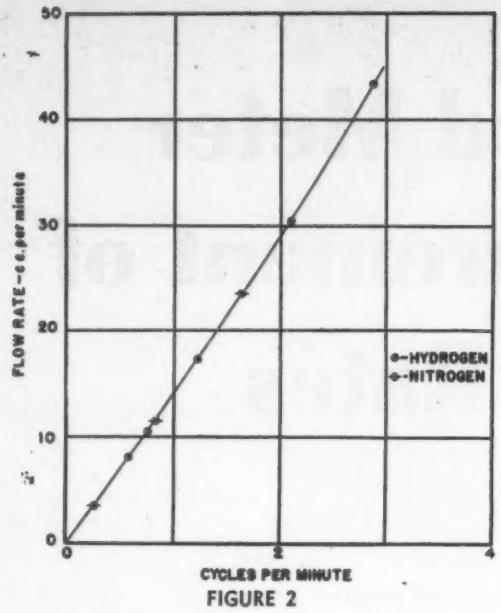

FIGURE 2

not met, a jet of gas will flow through the tube during a part of each cycle. The amount of gas will be a function of the gas viscosity and the calibration curve will then be found to depend on the kind of gas.

The requirement that there must be a drop of mercury in the horizontal tube at every part of the cycle suggests the use of a tube of relatively large diameter and as short as possible for the mercury piston, in order to reduce the time lag. However, in such a tube the mercury level tends to oscillate for some time after a drop is discharged at *E*, thereby producing a series of drops at the left instead of one. The constriction in the vertical tube at *F* reduces these oscillations; the long zigzag horizontal tube, shown in the top view, ensures complete damping of the oscillations of one cycle before the second begins and minimizes possible errors from fluctuations in the size of the mercury drops. In the authors' instrument 2 drops are formed at the beginning of every cycle when the flow rate becomes greater than 15 cc. per minute and as this rate is approached there will be 1 drop one cycle and 2 the next. However, the total volume of mercury remains very nearly constant, as the calibration curve proves. Above 35 cc. per minute 3 drops are formed. The tungsten contacts shown in the top view actuate a counter through a relay, so that the instrument may be used to record total flow as well as to measure the rate.

The surface of the tubing through which the gas and mercury droplets flow should be free of any oil or water film or dust particles, and the mercury should be pure; otherwise there will be small fluctuations in the rate of gas flow which may give pressure variations as high as 1 or 2 mm. of mercury. This effect can be eliminated in any case, however, by having a surge chamber in the line following the meter.

Since the volume displacement per cycle does not depend on the pressure or temperature of the gas, the instrument may be used at subatmospheric pressures. During any particular run, however, the temperature and pressure should have constant values; otherwise it would be difficult to convert the gas volumes to standard conditions. The meter could also be adapted for use at superatmospheric pressures by using metal parts or suitable plastic tubing and connections.

Acknowledgment

The authors are greatly indebted to Harold Gershinowitz for his interest and advice.

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Pew Never Opposed Oil Price Increase

CONTRARY to a recent statement made by Drew Pearson in his newspaper column, J. Howard Pew, president of Sun Oil Company, has never opposed a price increase for crude oil, and he has so informed the columnist. Pew's letter to the Washington commentator is as follows:

"Your column of February 10 from Wichita Falls, Texas, gives the impression that I have been opposed to a price increase for crude oil. Nothing could be farther from the truth, for I have unequivocally supported the fight to raise the present unfair price ceiling on petroleum and its products.

"You have undertaken to create this impression by stating:

"Howard Pew, of Sun Oil, testifying at a hearing in Washington, frankly admitted: 'I am very keen on getting the cost of crude oil down as low as possible.'

"This quotation was torn from its context in testimony which I gave as a spokesman for the American Petroleum Institute before the temporary National Economic Committee on September 26, 1939. My testimony on that occasion, more than four years and four months ago, when an entirely different situation existed in the industry than exists today, obviously, had nothing whatsoever to do with the present price situation in regard to petroleum and its products. Moreover, I was not discussing prices at that time but rather 'costs of crude oil.' There is a distinction between 'costs' and 'prices,' for the fairness of the price of a commodity can be judged only upon the cost of producing and marketing the commodity.

"I have been a lifelong advocate of doing everything possible to reduce the costs of producing, refining and marketing crude oil in order that finished products can be sold to the consumer at lower prices. But I have never advocated the reduction of a price below the cost of production plus a reasonable profit. At the hearing cited in your column, and recorded upon the same page of the printed hearings as the statement which you quoted, I pointed out that crude oil production was an unprofitable operation at that time.

"For many months I have supported the movement within the petroleum industry to persuade the Office of Price Administration and the Director of Economic Stabilization of the urgent necessity of raising the price of crude oil so the industry might fulfill its obligation to produce sufficient oil to meet the needs of the war program. As a member of the Petroleum Industry War Council, I voted last November for that body's resolution criticizing the failure of the Offices of Price Administration and Economic Stabilization to permit a price increase for petroleum and praising the efforts of Petroleum Administrator for War Ickes in seeking to obtaining an increased price.

"I have set forth in some detail my reasons for advocating an increase in crude oil prices in the annual report of Sun Oil Company, now in the hands of the printer, which will be published within a few days. I shall see that a copy of this report is sent to you and what I have said there should convince you of the erroneous impression given by your column."

FOR NON-FERROUS CHEMICAL PLANT NEEDS: *Check materials*

by REVERE

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Rubber Program Reaches Controversy and Confusion Stage

PRODUCTION from half the designed capacity of the butadiene plant of Neches Butane Products Company, Port Neches, Texas, provided fuel for the controversy and confusion within the synthetic-rubber program just as it added raw material for synthetic (GR-S) rubber itself. The record is that this plant is operating at the rate of 50,000 tons of butadiene per year, with its second identical unit to come on stream later this year.

Since it was designed to be the largest butadiene plant within the whole synthetic rubber program, publicity to that effect found ready acceptance with the result that objections shortly came through governmental channels, with the alcohol industry watching intently. The facts were that the Port Neches plant was putting but half its designed 100,000 tons per year on stream, while at Institute, West Virginia, an alcohol unit of Carbide and Carbon Chemicals Company had its plant, designed for 80,000 tons per year, producing at a rate in excess of 100,000 tons.

Assurance came from Colonel Bradley Dewey, Rubber Director, that the calculated production of synthetic rubber for 1943 would be met. Reaching the goal would be due to the fact that alcohol is responsible for more butadiene than was anticipated, leaving the conclusion that petroleum plants are behind schedule.

The explanation for this came from several sources, one being Bruce K. Brown, Assistant Deputy Petroleum Administrator, who praised the alcohol industry in his speech at Port Neches and added that high priorities had been given alcohol plants, since 11 identical units could be built from identical plans, a decision by which the rubber director came to rubber in the shortest period.

Costs of rubber from the two sources scored heavily in favor of petroleum when Stanley T. Crossland, vice president of Rubber Reserve Company, testified before a House committee of appropriations. From alcohol at 90 cents a gallon, cost of butadiene is such that GR-S rubber finally costs between 50 and 45 cents a pound. With butylene as the raw material at 9 cents a gallon, cost of rubber is 20 to 25 cents per pound.

"Unfortunately," he told the committee, "all plants will not have the same production costs, so that will vary. If we can make butadiene at 8 cents a pound and styrene at 9 cents a pound, we can make crude synthetic rubber for around 12 to 14 cents a pound."

Assurances of meeting records and filling essential needs were difficult for the public to comprehend. Reasons:

The allotment of synthetic rubber previously allotted for tires in the first half of 1944 had been cut in half;

More drastic tire rationing restrictions were announced by OPA;

The Rubber Director denied synthetic rubber to other civilian uses, even girdles.

In addition to raw material shortages and limited finished synthetic rubber, there is another reason for lack of finished rubber goods. Manufacturers have not yet learned how to work the synthetic product into all useable goods. This was admitted in Beaumont the night after the Port Neches plant was dedicated when James J. Newman, vice president of The B. F. Goodrich Company, spoke at the annual meeting of the Beaumont Chamber of Commerce. The technician, he explained, "Has not yet reached the point where we can be indifferent to natural rubber. Far from it. And it is no absolute certainly that we will reach that point in any given number of months, or even years, although technicians are optimistic."

Newman made it clear that many products are now being made from synthetic rubber "and with good results." "Proportions of synthetic in all sorts of products have been steadily increased, even including heavy-duty tires for military as well as civilian uses. But that switchover will have to continue at a faster and faster rate all through the year, for in the face of our exceeding scanty working supply of natural rubber the demand for military and essential civilian rubber products will continue to grow greater and greater."

He admitted that higher output of butadiene is the first essential to solution of the amount of synthetic rubber and mentioned the Port Neches opening as evidence of what is coming, adding, "it will be the performance of those plants which will really determine the speed with which the synthetic-rubber program as a whole reaches its ultimate production rate of 820,000 tons annually."

Although the output of butadiene from petroleum is still around half of its designed capacity, plant construction is estimated at 85 percent complete. Production from half the capacity at Port Neches, 50,000 tons per year, will permit copolymerization plants of The B. F. Goodrich Company and the Firestone Tire & Rubber Company to come into production. These plants, adjacent to the Port Neches butadiene unit, have combined capacity of 120,000 tons of rubber per year.

Port Neches Celebration

Dedication of the first unit at Port Neches brought officials of the agencies of government, state officials, civic leaders, officials of the five participating oil companies and workmen still on the second unit construction job together for an hour February 23. Later there was a reception and banquet in Port Arthur.

Colonel Bradley Dewey discarded his prepared statement at Port Neches and devoted most of his remarks to the men who built the first unit and are completing the second. To these men he stressed the necessity of realization that their work is a part of the military program. He pointed to the operating unit as representing 12,000,000 tires, "already sold to the military." He cautioned that the second unit will represent another 12,000,000 tires, "part of which we may get for civilians."

To civilians he advised continued good care of casings with frequent recapping, which represents the status of one casing on his car. As for non-essential driving, he said:

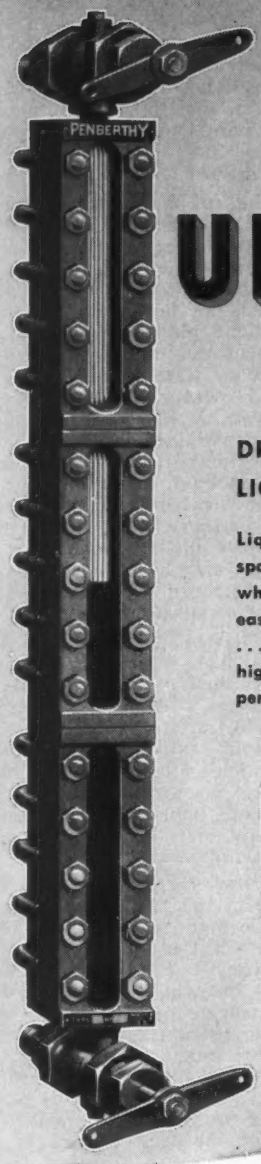
"That's alright to dream about and hope for, but we must not kid ourselves. We are still fighting a war."

He estimated that the nation will be able to meet its present scheduled war needs this year and pointed out that the synthetic-rubber industry will be able to turn out an additional 18,000,000 to 24,000,000 civilian passenger tires.

The history of the Port Neches project and much of the part the petroleum industry is playing in the synthetic rubber program was explained by Bruce K. Brown, assistant deputy, Petroleum Administration for War. He recalled that the project was discussed while Pearl Harbor still was smoking and that the original process proposed butane as a raw material by way of showing the changes that have come about. Concerning the change to butylene feed he added:

"In view of the highly satisfactory record of performance of the butylene-to-butadiene process for several months at your sister refineries at Baton Rouge and Baytown, I am sure that you will have good success with your changed plan. I say this in spite of the alleged 'butylene shortage' conjured up by professional worriers."

He paid glowing compliments to the alcohol industry for its part in the butadiene program and stressed the attitude of the Petroleum Administration for War, which is that the urgent need is for rubber. After giving details of the organization of the non-profit corporation, Neches Butane Products Company, by The Atlantic Refining Company, Gulf Oil Corporation, Magnolia Petroleum Company, The Pure Oil Company and The Texas Company, he spoke of



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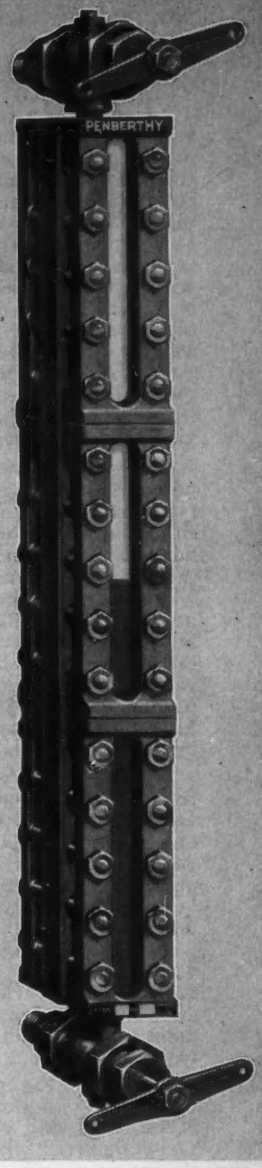

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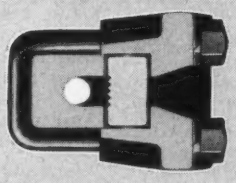

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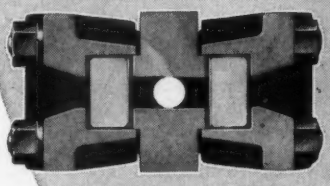

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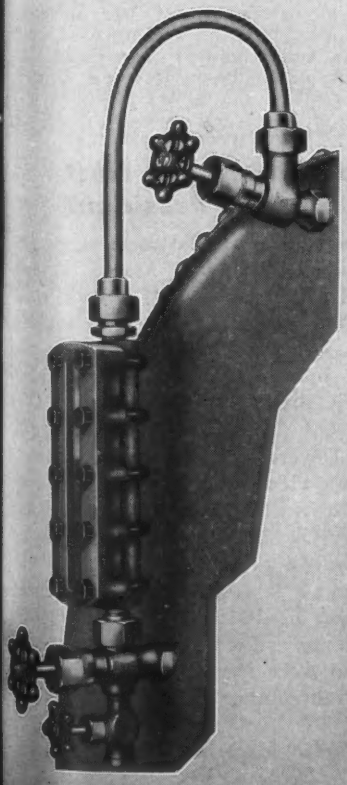

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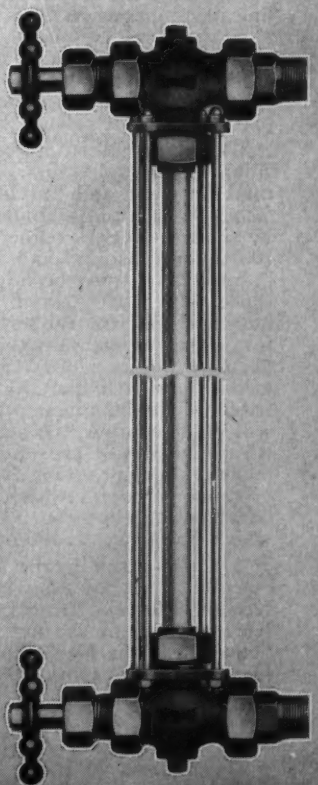

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the plant and its relationships to both the petroleum industry and the synthetic-rubber industry, as follows:

"A small part of the normal butylene which you produce in the five refineries in the Neches area is the raw material from which butadiene is made in this government-owned, industry-operated plant. The price which each of you is to be paid for this raw material was separately negotiated by each of you with Rubber Reserve Company. The cost methods used in determining each of these separate prices were the same as those developed by the Petroleum Administration in its 100-octane program. Rubber Reserve used the Petroleum Administration as a technical advisor for this purpose.

"Butylene is known to the authors of popular science articles as the mystic material from which one can produce either butadiene or 'alkylate'—a component of 100-octane gasoline. Well, like the man who was amazed to be told when he wrote, he wrote 'prose,' many people may be intrigued to learn that butylene was present in all prewar cracked gasoline. In fact, it was a highly valued constituent having an octane number of over 80. It did not need to be separated out—it was just one of many components of gasoline.

"However, the principal aim in life of refinery technologists and the Refining Division of PAW for the past two years has been to dig that butylene out of gasoline in order to use it for the production of war products. But all of the butylenes actually available to be removed from prewar cracked gasolines were far from enough butylenes for the war program and it has been necessary to build 'cat crackers' to produce more as well as elaborate distillation equipment to separate the desired butylene from its petroleum cousins.

"It should be noted for the record that even with the vast new equipment investments and operating costs necessarily incurred, the contract prices for the butylene which you supply to the Neches plant are only a fraction of a cent a pound more (or a few pennies more per gallon) than the current wholesale price of premium motor gasoline at refineries in this area. Incidentally, the total volume to be supplied—about 4500 barrels per day—is less than 1 percent of the total daily output of refined petroleum products of the five participating petroleum refineries.

"It is true that this volume is a considerable though minor portion of the total butylene and butylene equivalents (iso butylene and amylenes) to be used by the five Neches refiners in producing 100-octane gasoline and butadiene. But in addition it must be borne in mind by those who have feared a shortage of butylene for the rubber program that for every refinery making 100-octane gasoline in the United States which is called upon to make any butylene contribution for butadiene production, there will be five other 100-octane producers whose butylenes are not needed at all in the rubber program as well as a host of other refineries which are supplying butylenes, either as such or as 'codimer,' which flow into the 100-octane program.

"One hundred-octane gasoline is an essential part of the history of the Neches butadiene project. Prior to Pearl Harbor three of the five refineries participating in the Neches project were already making some 100-octane gasoline, and some expansions of capacity were in progress. In the very early months of the war, contracts were concluded with all five refineries looking toward the eventual production in existing equipment and in new equipment of an amount of 100-octane gasoline in excess of 10 percent of the entire gasoline program. The decision by Rubber Reserve Company to authorize the Neches project was also made very early in the war, but nevertheless, somewhat later than the several 100-octane construction programs had been authorized. In order to accommodate both war production programs, that is butadiene and 100-octane, it was necessary in some cases to change and augment the original plans for new refinery construction for war production. All this was done cooperatively by the companies themselves, Rubber Reserve Company, and the Petroleum Administration.

Construction Delays

"In the first wave of planning for synthetic rubber production, the Neches unit was scheduled for completion at a very early date. Although most fair-minded people understand today something about the shortage of the priority system, and why some war projects are completed ahead of others, I'd like to state for you and for the record why we are opening the Neches plant in February, 1944, and not on the earlier date originally scheduled.

"In the feverish months following Pearl Harbor, our basic problem was, of course, that we needed more war products in a hurry than we had the raw materials, plants and manpower to produce—or the materials and manpower to build the plants.

"Take the matter of valves—the muscular controls of every butadiene project. Urgently required as they were to help make rubber, they were needed just as badly in naval escort vessels, in 100-octane plants and for scores of other vital war programs. The same is true of compressors. You had to compete with landing craft, so essential for amphibious invasion, and with many other projects, to get special steels. And so on down the list. Somebody had to get first crack at those vital materials—and you were not the ones.

"I can remember very well the anguished visits which the chief executives and chief technologists of your companies made to the several agencies in Washington on various occasions to urge that high priorities be granted so that materials might be obtained with which your contractors might complete the projects promptly. It was not possible for such priorities to be granted until a late date.

"The famous 'freeze directive' which was issued to certain of the synthetic rubber plants and certain of the high-octane plants about 13 months ago did not include the Neches project. The rubber director has recently explained that, when he was denied 'super priorities' for the whole rubber synthesis program, and had to make the hard choice as to which projects should be favored, he placed most his chips on butadiene production because of his conviction that that was the toughtest part of this problem. Having made this decision, he became so impressed by the possibility of finishing quickly 11 identical units concentrated on 3 construction sites that he threw the lion's share of the available super priorities to the alcohol-butadiene process. The chemical companies constructing and now operating the alcohol-butadiene plants responded handsomely to the challenge and, as I have said, are entitled to great credit for their achievement.

"But the rubber director's office did not place all of its eggs in one basket. It assigned a super priority to one of the butylene-butadiene units at Baton Rouge also. The basic process there is the same as you will use here and, like the alcohol-butadiene plants, the Baton Rouge job has been ticking along merrily at an over-capacity rate for a good many months. However, the Neches project had to wait. It had to be finished 'the hard way' with ordinary high priorities in competition with many other war programs. You have had no choice but to accept for the common good, and with as much patience as men who want to get a project finished can muster, whatever delays may have resulted from the decision of those who must direct the over-all program as they see it.

"Port Neches has its job to do. And when the last Army truck has been shod, last heavy bomber fitted with landing-wheel tires, the last order for rubber life rafts, tank treads, bullet-proof gasoline tanks and countless other rubber articles filled, there will be credit enough to go around for all groups, government, industry, and labor, that successfully met the greatest challenge American industry ever faced.

"What our synthetic rubber industry has done in the two years since Hirohito's little men overran the plantations of the Far East and cut our jugular vein—or so they hoped—has already been hailed as the greatest miracle of chemical engineering in history. As much as any single industrial achievement, perhaps, it will make possible the winning of the war. You who planned, negotiated, designed and built this plant, and those who will operate it, will have had a share in our final victory as real as though you wore a uniform. It will be something to tell your grandchildren."

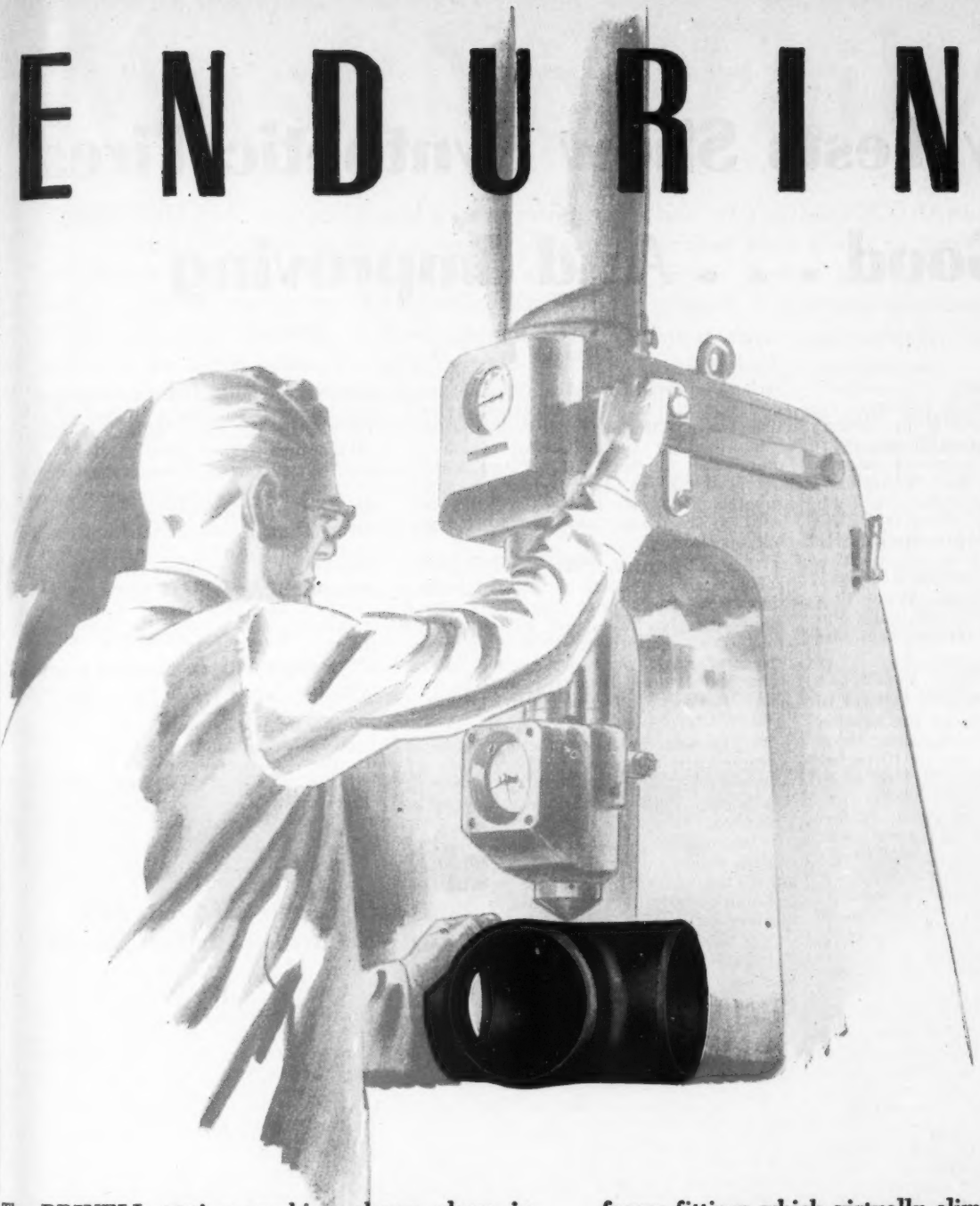
Fred P. Dodge, assistant to the vice president of The Texas Company, was master of ceremonies. Other speakers were Sidney Latham, secretary of state of Texas, and Stanley T. Crossland, vice president of Rubber Reserve Corporation.

California Refiners Elect C. A. Johnson President

At the eighth annual meeting of the Independent Refiners' Association of California, officers and directors were elected to serve during the ensuing year, as follows:

C. A. Johnson, Socal Oil & Refining Company, president; Henry Brown, Operators Oil & Refining Company, and B. E. Devere, Pathfinders Petroleum Company, vice presidents; A. M. Lockhart, Envoy Oil Company, secretary-treasurer; D. B. O'Neill, general manager, and D. S. Fletcher, Fletcher Oil Company; J. H. Lewis, Sunset Oil Company, and C. B. Limbocker, Hancock Oil Company, directors. Executive officers also were elected to serve on the board of directors.

ENDURING



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Army Tests Show Synthetic Tires Good . . . And Improving

INCREASED amounts of synthetic rubber are being used in products for military use. This trend is in keeping with the results of tests being made continuously by the ordnance department on tires for military equipment. These results are contrary to some popular reports to the effect that tires of synthetic rubber are proving unsatisfactory. No reports thus far indicate that tires of synthetic rubber are equal to natural-rubber products. What they do indicate is that tires are being improved and that the service they are giving is satisfactory.

An order of the War Production Board in January raised the amount of synthetic rubber in tires of the smaller sizes to 95 percent. The natural-rubber content of inner tubes up to 10 inches in diameter was reduced from 80 to 64 percent. Treads on all airplane tires will be 100 percent of synthetic rubber with the exception of beaching gear, fighter and ice-grip types; small bogie wheels will contain 92 percent synthetic rubber; tire cord dip after February 1 was changed to allow 50 percent of synthetic or reclaim rubber, and compression type mountings after March 1 contain no natural rubber except for certain types.

Actual service results from tires of synthetic type, GR-S, rubber were given before the meeting of the Society of Automotive Engineers in Detroit, January 10, by Lt. Col. B. J. Lemon and Capt. J. J. Robson of the development branch, U. S. Army Ordnance. Testing grounds in California and Texas require some driving over rough terrain, which commercial tires seldom encounter. In view of impression of unsatisfactory service from GR-S rubber in tires, this part of their report is significant:

"The small-tire group in the Army is largely devoted to 6.00-16 tires for the quarter ton, 4x4 truck, known as the jeep. The first tests run were synthetic treads on natural-rubber carcasses, which showed such promising results that tests were next conducted on 100 percent synthetic tread and carcass construction.

" . . . tests of the first of these tires at Camp Seeley, operating at 50 miles per hour, sustained speed at atmospheric temperatures up to 115° F. These were run 10,000 miles on our standard course, then shifted to a 40 percent gravel course. It will be noted that the tires show a few failures after 13,000 to 15,000 miles, which is a very good record for such severe conditions.

"Also . . . the same 100 percent synthetic tires tested at Normoyle, operating on the highway at 55 miles per hour and on severe cross country at reduced speeds. Here again they took very good.

"These tests, together with numerous rechecks, proved conclusively that 100 percent synthetic tires are successful in small tire sizes. Later a qualifying test was established at Camp Seeley, which required that the tires run 5,000 miles without heat failures. Twenty-four companies supplying this size have passed this test, with most groups running 10,000 miles without failure.

"Since February, 1943, when synthetic rubber started to come into limited production, small tires have been 100 percent synthetic. They are doing an outstanding job, as is certified to by the following comment from D. G. Roos of Willys-Overland Motors, Inc., on a test his company ran with 100 percent synthetic, 6.00-16 tires.

" 'The wear on the synthetic tires is no greater than the wear on tires made of crude rubber. The synthetic tires seem in every way equivalent to the crude-rubber tires.'

"We feel these tests on small-size tires should remove any serious questions about synthetic from the mind of the fleet owners who are operating large groups of passenger vehicles or light trucks.

"It has been rumored that the synthetic passenger-car size of tire can not be driven over 35 miles per hour or that it will not give adequate mileage. Our factual data, derived under test conditions more severe than any civilians should be driving today, prove that this rumor is not true.

"To show how Ordnance feels about these 100 percent synthetic tires in the smaller sizes, we have bought over a million and so far we have not had a complaint from the using troops, who are our customers.

Medium Tires

"The medium tire group (7.00-inch, 10-ply through 10-inch) is by far the most important since it consumes approximately 70 percent of all the rubber in the Army's pneumatic tires. It is probably the most important to fleet operators since the tire sizes involved are those used on the great highway fleets as well as most of the trucks used in city or short-haul work.

"The first tests were run in May, 1942, using synthetic treads, and the results were something of a shock. These tires, tested at Camp Seeley at 35 miles per hour sustained speed, 20 percent overload per tire, with 10 percent gravel, resulted in a severe cracking condition.

"The same tires at Normoyle, on cross-country service, developed severe chipping and cracking at very early mileage.

"These tires demonstrated one of the principal weaknesses of synthetic rubber—lower resistance of the tread to cutting, chipping and cracking, both on the highway and cross country. Synthetic rubber has poor tearing resistance, which means that once a slight cut or crack has started it progresses rapidly.

"This phase of the problem, the resistance to chipping and cracking, has been greatly improved by intensive work by industry chemists. The improvement is very noticeable since these tires at 10,000 to 18,000 miles are neither chipped nor cracked so badly as the previous group at 3000 or some at 6000 miles.

"Controlled tests are now being run over the Alaska Highway to determine the results on all-gravel operation. A number of tires running there have just been examined and apparently even under these severe conditions the synthetic tires will perform successfully. This will be of interest to operators who operate a lot on gravel roads, particularly in the North Central and Northwest States."

Increase for Past Year Natural Gasoline Shows

Natural gasoline and allied production in 1943 reached 3,703,518,000 gallons, against 3,499,524,000 gallons in 1942, it was reported last week by the Bureau of Mines. Over-all increase in production last year was 6 percent, but gains of 7 percent were recorded in Texas, 9 percent in California and 32 percent in Illinois, with a loss of 5 percent in Oklahoma.

December production totaled 327,516,000 gallons against 322,854,000 gallons in November, but daily average output dropped to 10,565,000 gallons from 10,762,000 gallons.

The 1943 production, it was shown, included 2,025,744,000 gallons of natural gasoline against 2,071,104,000 gallons in 1942; 686,794,000 gallons of cycle products against 654,864,000 gallons; 170,184,000 gallons of iso-butane at natural gasoline and cycle plants against 101,682,000 gallons; 824,796,000 gallons of other liquefied petroleum gases at natural gasoline and cycle plants against 671,874,000 gallons; 170,898,000 gallons of liquefied refinery gas at refineries against 226,842,000 gallons, and 100,800,000 gallons of benzol against 100,674,000 gallons.

Stocks of natural gasoline and allied products decreased during December and at the end of the year were 190,722,000 gallons, compared with 195,090,000 gallons on November 30 and 194,544,000 gallons on December 31, 1942. The year-end stocks included 103,152,000 gallons at refineries and 87,570,000 gallons at plants and terminals.

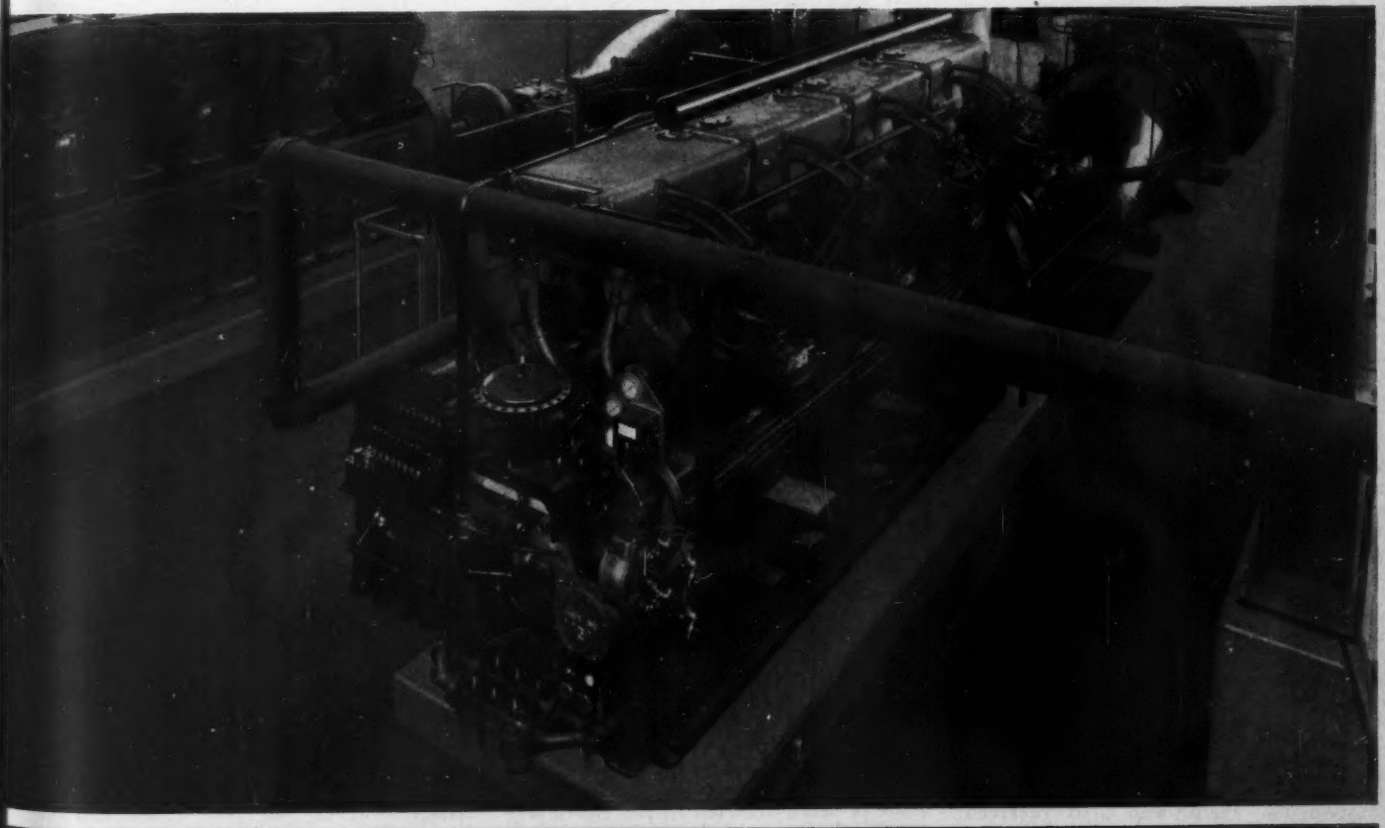
Must Not Fail!

PUMPING 250,000 gallons of water a minute . . . 360,000,000 gallons a day . . . these two 800 h.p., Cooper-Bessemers supply all the water used at the giant $45,000,000 Port Neches, Texas, synthetic rubber project. The engines are 8-cylinder, V-angle Type G-MV's, so designed that they are readily convertible for diesel operation if that should ever be advisable.

Engine speed and pumping performance are accurately regulated by special Cooper-Bessemer automatic controls, so that both volume of water delivered—and water pressure—are maintained at exactly the desired figures at all times.

The tremendous quantities of water required for steam and processing indicate the importance of these pumping engines to the production of the 100,000 tons of crude butadiene rubber this plant is expected to turn out in 1944. And it is significant of the confidence placed in Cooper-Bessemer G-MV's that they must run continuously, day and night, without standby equipment.

Dependability and freedom from operating troubles are Cooper-Bessemer qualities long known to men in the oil and gas industries. There are millions of Cooper-Bessemer horsepower that have been working steadily for years . . . in the oil fields, in refineries, natural gasoline plants, gas transmission stations and processing plants. No wonder that whenever men need utmost reliability in an engine or a compressor they turn to Cooper-Bessemer.



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War Requirements Responsible For Refining Records

Review for American Institute of Mining and Metallurgy Deals with raw material sources other than oil

IN HIS review of refining developments during 1943 as outlined in the February issue of Mining and Metallurgy, Walter Miller, vice president of Continental Oil Company and chairman of the AIMME committee on refinery engineering, explained how sufficient aviation motor fuels had been provided despite lack of sufficient equipment for completing all refinery projects as originally desired. Conversion of existing units to aviation gasoline production was chiefly responsible for the accomplishment.

The spending of $900,000,000 for aviation gasoline facilities in two years was accepted as an indication that at least $2,000,000,000 had been spent for the refinery expansion program in that period. When it became obvious in 1943 that sufficient new equipment was not available for providing new facilities to meet the mounting military need, efforts of the industry and the Petroleum Administration for War were turned to solutions from existing equipment.

How this was done was thus outlined by Miller:

"Among the things that contributed greatly to making up the deficiency caused by construction delay were the following: (1) The expedient of metamorphosing polymerization plants into codimer-producing units and finishing that product into commercial iso-octane of 92- to 98-octane number by utilizing the capacity of the industry's four large existing hydrogenation plants. (2) Removal of bottlenecks in existing units by changes increasing capacity at comparatively small expense of time and critical materials. (3) The making of cumene by chemically joining benzene and propylene. (4) Separation and utilization of iso-pentane from normal gasoline. (5) Increasing the output of alkylation plants by making more raw material available to installations developing higher than design capacity. (6) Searching the industry to bring out and make usable more of the straight-run, high-octane-base gasoline contained in crude oils to combine with catalytically cracked gasolines for blending with the above high-octane components. Help was also received from the toluene program as the production of that product was found to exceed military requirements (in part brought about by the development of new explosives), toluene making a valuable 100-octane component. 'Recently an Army General stated to Administrator Ickes: 'The job which has been done with 100 octane by the refinery experts of your staff and of the oil industry is one of the most amazing things I have ever witnessed. It is almost unbelievable. They have virtually squeezed it out of a hat.'

"Although a temporary shortage of 100 octane for training purposes has existed at different times and places in this country, never has there been any interruption in plane operations overseas because of its lack. A late-in-December statement by the chief of aviation fuel branch of the War Department is to the effect that refineries, working overtime as they are, are producing sufficient aviation gasoline to meet consumptive requirements for both training and overseas.

With the 38 new plants coming into operation from time to time during the next four months, production by May should surpass temporarily the constantly increasing demands of the augmented plane-production schedules and combat activities and should build up reserves to carry the situation safely over to the latter part of 1944. By that time the 22 additional units authorized in 1943 will be coming on the operating line, and the industry will be in a position to supply without fail all requirements that can be foreseen for the duration — constituting an enviable record of accomplishment!

Toluene for TNT

"The toluene problem of the industry is solved. Ordnance Department's estimates of ultimate requirements were somewhat reduced because of better experience and knowledge of possible rates of consumption and also by virtue of the development and manufacture of one or two new explosives, more suitable for certain objectives than TNT.

"Hydroformer installations, the catalytic re-forming process which converts certain petroleum aliphatics to aromatics principally of the toluene and xylene types, and the attendant toluene extraction and purification plants were completed to a total capacity beyond the reduced estimated requirements. As a result of the lesser needs for explosives, from a quarter to a third of the toluene production as well as some of the zylene made is being diverted to the 100-octane activities, for which purpose these chemicals are almost as valuable a blending component as the commercial iso-octane being produced by the alkylation process installations. The high-octane and high-rich-mixture characteristics, and the favorable boiling ranges possessed by these chemicals, enable important increases in 100-octane output.

"The Toluene Technical Committee, organized in 1942 under the auspices of Ordnance Department and working in collaboration with PAW, has continued to function with even greater effectiveness, with results apparent in the greater and quicker increases in production of this indispensable chemical. The activities and accomplishments of this committee will furnish one of the best illustrations of the war in accomplishments brought about by the wholehearted, full-scale co-operation of the industry with the armed forces and through PAW.

High-Quality Lubricating Oils

"Eight major and about 20 minor building projects for increasing output of war-purpose lubricating oils make up the total program since Pearl Harbor. Five of the major projects were announced by PAW as being completed and in production by the end of 1943; the other three will be finished early in the new year. Most of the 20 minor projects have been finished with resultant greater output from the existing facilities with which these 'bottleneck removers' are associated.

"As the situation now stands, ample reserve stocks and current production capacity of lubricating oils exist for aviation and other military and lend-lease purposes. All necessary requirements for industrial and general uses are and will continue to be met, and reserves in stocks and production rates are sufficient to ensure all possible requirements. This activity, all financed by the industry without public funds, constitutes additional evidence, as stated by Deputy Administrator Davies of PAW, 'of the patriotic co-operation which the petroleum industry has accorded the nation in its remarkable conversion from peacetime to wartime production.'

"This problem too is solved, and any apprehension previously felt has been removed.

Synthetic Rubber

"During 1943 new estimates were made from time to time of requirements of the armed forces and lend-lease based on 1942 and 1943 actual experience. The quantity of 1,074,000 long tons of synthetic rubber per year recommended by the Baruch committee in 1942 was changed to 850,000 long tons, the figures used in Progress Report No. 4 of Rubber Director Bradley Dewey, issued November 10, 1943, and from which some of the following is gleaned.

"On October 31, 1943, construction with a rated capacity of 646,000 long tons was reported as completed. Full rated production of course is not im-

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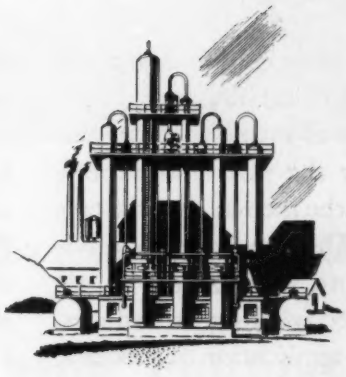

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mediately attainable upon completion of construction. The Report No. 4 estimates show an annual production rate for the last quarter of 1943 of 493,000 long tons and for the first quarter of 1944 at a rate of 665,000 long tons per year of all types of synthetics, the annual rate for the fourth quarter of 1944 being estimated at 896,000 long tons, indicating the completion then of the present program. In view, however, of the still existing shortages of construction materials and plant facilities, labor recruiting difficulties, and lessening of work effort, as well as other factors entering the picture, I believe that the above estimates are on the optimistic side by about 3 months and that Dewey's timing that 'the next 6 to 19 months will be the most difficult' will probably extend to 12 months. The ordinary civilian still faces a long period before removal of the restraints which now beset him.

"The 'butadiene from alcohol for rubber' part of the program is practically completed; and of the synthetic production rate at the end of the year, some 220,000 long tons per year is alcohol's contribution, with possibly another 10,000 to 25,000 per year in sight as operations are smoothed out, higher efficiency is attained, and minor bottlenecks are eliminated by virtue of increasing operating skill. Eleven units in three plants, identical in design and material requirements, were erected and put in operation within a minimum building time, speed having been made possible by special priorities. Sufficient alcohol has been allocated by WPB to run the units at capacity.

"Increasing natural rubber importations, even though on a small scale, are helpful, being estimated at 60,000 long tons for 1943 and 80,000 in 1944.

"The petroleum refining program for producing raw materials, principally butadiene, from petroleum is behind earlier hopes and estimates. The same difficulties encountered in the 100-octane construction work, namely, shortage of man power in engineering and design and in field construction, and late availabilities of construction equipment and materials because of competition with the shipbuilding, aviation, munition and armament programs, all made for delays in completion of plants. Three or four of the larger installations originally scheduled for considerably earlier completion dates are now expected to go into operation during the first four months of 1944, the largest of them all, the 120,000-ton-per-year installation at Port Neches, Texas, either late January or early February. The latest official report states that on October 31, 1943, 39 percent of the petroleum division units contributing raw materials to synthetic rubber were complete, either producing or going into production.

"A number of changes were made in the production program in effect early in the year. Projected production of butyl rubber was cut to less than half, and greater emphasis placed on Buna S rubber from butadiene as more suitable for military usage. Neoprene rubber originally set up at 60,000 long tons a year is now planned for 40,000.

"A good job has been done, although the present-day results are disappointing in view of earlier estimates and predictions; however, a comparison of the situation now, and as foreseen for a year from now, with the bleak outlook and the muddled, conflicting forces

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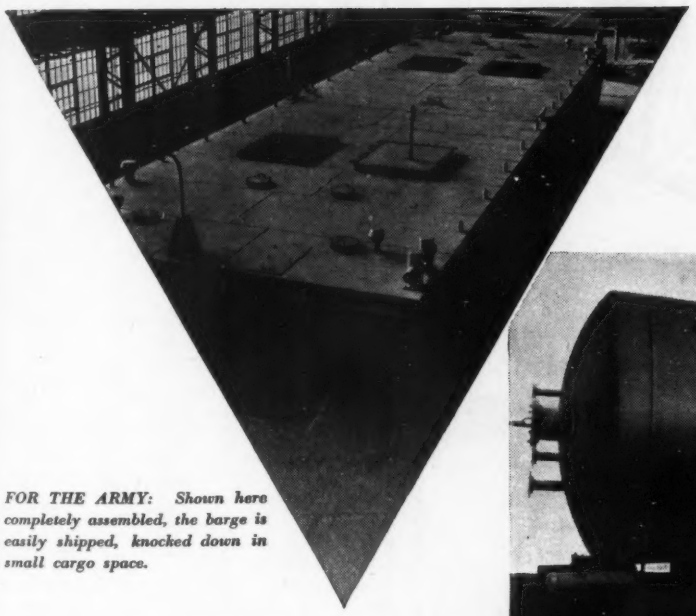
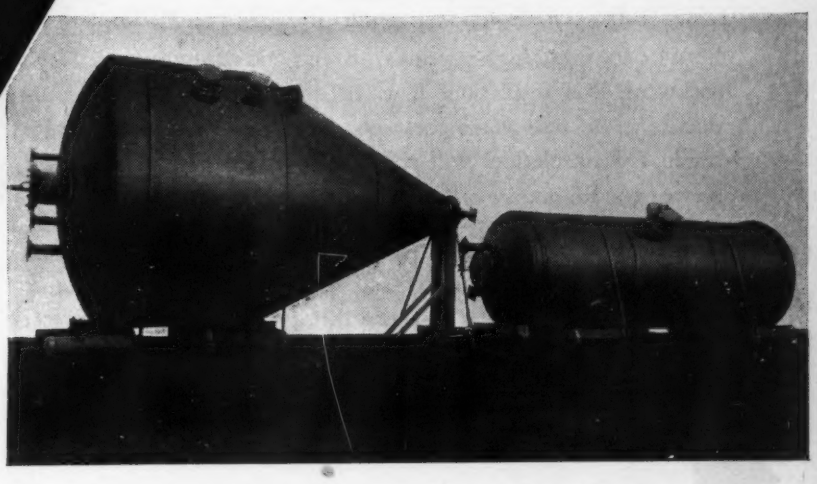


FOR THE ARMY: Shown here completely assembled, the barge is easily shipped, knocked down in small cargo space.



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For the Port Neches Project, Baldwin-Hill supplied 198 tons of piping insulated with Insidline. This is an internal insulation built-up inside of ordinary carbon steel pipe that enables it to withstand temperatures above 1000° F. Insidline is typical of Baldwin-Hill ingenuity in meeting heat and cold problems.

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involved in the general problem a year and a half or two years ago, justifies a feeling of pride in what has been accomplished by all individuals and interests actively connected with synthetic rubber.

"No specific information has been given out as yet of costs of synthetic rubber, and it is doubtful if any really reliable figures are currently available. Sometime in 1944, however, it should be possible to evaluate the relative costs of synthetic rubber from alcohol and from petroleum products compared with crude plantation rubber from South America, Africa, and the East Indies.

Research and Development

"Research and development efforts continued co-operatively under the joint auspices of the Petroleum Industry for War Council and Petroleum Administrator for War largely through the activities of the Aviation Gasoline Advisory Committee, the Toluene Technical Committee, and the Technical Advisory Committee, with a large proportion of the more experienced refining technologists and experts in the industry actively engaged in the work.

"Although previous reference has been made to the contributions of these technical efforts to the 100-octane and toluene program, the knowledge and ability and experience represented by this group is directed in many other directions, always of course with promotion of the war program as the guiding aim. Practically none of the important accomplishments are available for general publication, but all information is immediately made available to the directly interested technical workers and those refiners whose operations will be benefited thereby.

"The immediate value to the war effort of this research work and the development of the new techniques and products is both indispensable and incalculable, but the value will not stop with the end of fighting. The entire refining industry is being lifted to a higher plane of accomplishment, to a level which will quickly broaden its peacetime accomplishments to a degree which would have taken years of ordinary progress. The impact of the industry on chemistry and chemicals of the future, the experience leading to better products and better utilization of the less valuable fractions of petroleum by conversion to materials for new fields, will unquestionably increase petroleum's contribution to the well-being of mankind to degrees beyond anything hitherto accomplished.

Catalytic Processes

"Progress made in catalytic operations of all kinds is already discernable. Catalytic cracking is rapidly displacing the comparatively inefficient thermal cracking operations and this trend will be extended much further after the war as construction materials become available and as designs for smaller-scale catalytic cracking units are developed for the intermediate and smaller-size refining units. Catalytic cracking establishes a trend to the conservation of crude oil in that more and better motor fuel and furnace oil is made possible with a material reduction in production of heavy low-value industrial fuel oil, largely a by-product of thermal cracking. Catalytic processes will be utilized to a continuing greater extent in mak-

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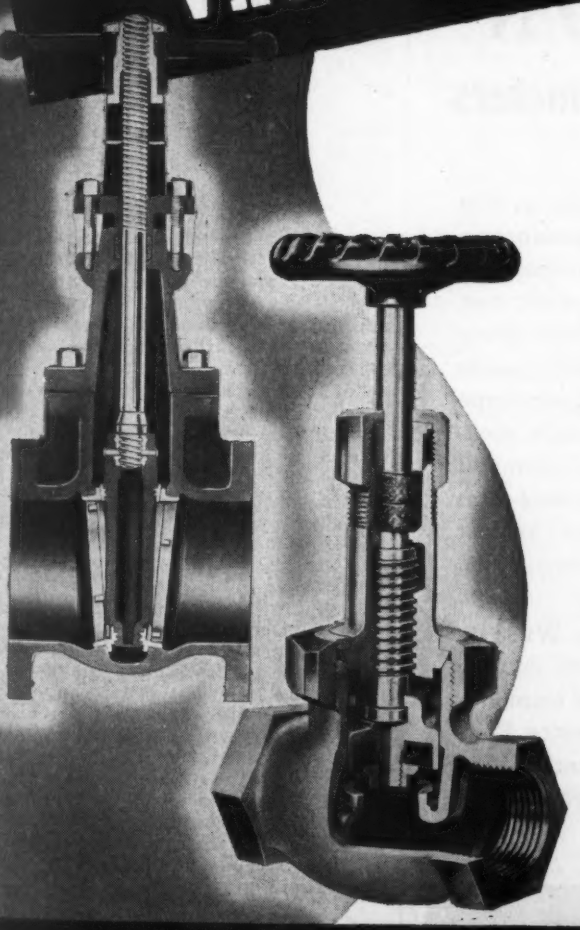

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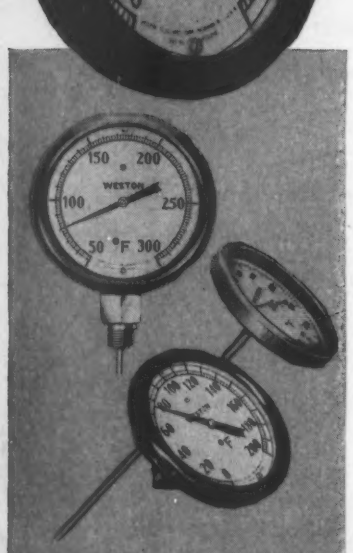

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ing liquid fuels out of normally gaseous products and converting to bases for the manufacture of chemicals. Catalytic processes will bridge the gap to the next conservation step of catalytic oil hydrogenation, technically and practically worked out but not now commercially feasible. Catalytic operations coupled with oil hydrogenation will put off appreciably the day when other and more costly sources of hydrocarbon liquids will have to be tapped to eke out dwindling supplies of crude."

His review of refinery throughput, the increase in aviation gasoline and the consequent demand for more oil was discussed in the light of crude oil discoveries, which are less than current crude requirements. This brought the following digest of other possible sources of raw material:

"(1) Oil shale is one such course, known deposits in this country containing an estimated 400,000,000,000 tons with an estimated recoverable content of 90,000,000,000 to 100,000,000,000 barrels of oil, available as and when economic conditions justify the necessarily large installations and investments.

"(2) Wider interest has been stimulated in the 'tar' sands, oil-saturated sands in the Athabaska region in Northern Alberta in which small-scale operations have been carried on for some time. Their location is about 500 miles north of the United States border and 500 miles from the Pacific Coast. An enormous deposit is in evidence, estimates ranging from 100,000,000,000 to 250,000,000,000 barrels of potential oil.

"(3) Hydrogenation of coal to liquids, an expensive but demonstrated operation carried out in England and Germany, with a practically unlimited supply of raw materials, is another potential source. A bill before Congress, already approved by Senate, would appropriate $30,000,000 for building some fair-size demonstration plants by the government to work out design, operating and economic phases on the theory that it was a problem for government and not private business to carry on for the general future good of the country as a whole.

"(4) A fourth source is the making of synthetic motor gasoline from the great natural gas reserves in this country, a reserve which has been estimated at 95 trillion cubic feet and from which possible 10,000,000,000 barrels of liquid petroleum products could be obtained by using a modified catalytic liquefying process based on the Fischer-Tropsch methods used in Germany for making synthetic gasoline and other petroleum equivalents from coal.

"The question as to when and how the above sources will have to be utilized and in what order they will be tapped and what economic price levels for crude oils will have to be established and maintained to justify the new sources with their materially higher per-barrel over-all cost will be answered in the future. Apparently there is assurance of an ample supply of gasoline and other petroleum liquids for succeeding generations at a price."

Bureau Reports Analyses Of West Texas Crude Oils

"Analyses of Crude Oils From Some West Texas Fields," by Boyd Guthrie, petroleum chemist at the Bartlesville laboratory, has been issued by the United States Bureau of Mines.

Competitive Forces to Govern Petroleum or Alcohol Use in Synthetic Rubber Production

Extent to which the production of synthetic alcohol from natural-gas or petroleum-refinery gases may displace distillation from molasses and the magnitude of the synthetic-rubber industry will be the major factors affecting the industrial alcohol industry of this country after the war, the House ways and means committee was advised in a Tariff Commission report on the probable post-war industrial picture.

In the early part of the last decade, petroleum-base synthetic alcohol amounted to only about 10 percent of the production from molasses, but from 1935 to 1939 its importance rose rapidly, and in the latter year it amounted to 25 percent. Under the war program, with the whiskey distilleries turning to the production of grain alcohol and other grain plants built for the rubber program, the proportion of synthetic to other alcohols declined, the commission said, but after the war, it is expected little or no alcohol will be produced from grain and the extent to which petroleum will compete with molasses will depend upon the extent of synthetic-rubber production.

Production of synthetic alcohol last year totaled 36,000,000 wine gallons, and that from molasses 81,000,000 gallons, out of a total of 437,000,000 gallons, it was shown.

The greatest factor in the enormous increase in the output of industrial alcohol during the war has been its use in the manufacture of synthetic rubber, which accounted for 30 percent last year and may rise to more than 50 percent in 1944, the commission reported.

"The relative use, after the war, of alcohol and of petroleum for the manufacture of synthetic rubber may, of course, depend solely on natural competitive forces," it said. "However, the matter may be largely determined by decisions of the government, which owns nearly all the synthetic-rubber plants and can utilize them as it sees fit. It might, for one reason or another, decide to utilize the alcohol process for making rubber to the minimum extent or, at the other extreme, to utilize it to the maximum extent.

"Conceivably, with a view to conserving petroleum, the government might adopt a policy of reducing the use of the petroleum-rubber plants to a minimum. This could be done by limiting the total quantity of synthetic rubber produced. Or it could be accomplished by a shift from the petroleum process to the alcohol process, such a shift requiring considerable additional investment of capital.

"It is important in any case to note that use of petroleum as the material for a relatively large output of synthetic rubber would be only a very minor item in the total requirements for petroleum. If all the projected output of Buna-S rubber (700,000 tons) should be made by the petroleum process, the amount of petroleum consumed would probably be less than 1 percent of the present rate of production."

The commission also discussed the use of alcohol as a motor fuel, but pointed out that the amount required would be so great as to necessitate its manufacture from grain, increasing its cost so that it could not compete with petroleum. Grain would have to be used even for the manufacture of synthetic rubber, if the latter was maintained at any great volume after the war on an alcohol basis, since the supply of molasses is limited by the demand for sugar, which is relatively stable and insufficient to permit any great increase in alcohol production.

"If purely economic forces determine the situation, relatively little alcohol will probably be used for these purposes during the early post-war years," it was declared. "Only governmental measures taken for the purpose of conserving petroleum, or creating additional markets for farm products, especially grain, would cause large consumption of alcohol in such uses.

"Under the price conditions likely to prevail for some years after the war, it will probably be cheaper to use petroleum to make rubber than to use alcohol made from grain. Nevertheless, the desire to conserve petroleum, even in a small way, or to increase the demand for farm products, might conceivably lead to a policy of utilizing the alcohol-rubber installations to part or all of their capacity.

"Proposals for government measures requiring the admixture of a certain proportion of alcohol with gasoline in motor fuel, a practice common in various foreign countries where conditions differ greatly from those in the United States, have hitherto failed of enactment. The quantities of alcohol required to effect even a comparatively small conservation of petroleum would be enormous. If an admixture of only 5 percent of alcohol with motor fuel were required, this would involve the annual consumption of more than one billion gallons of alcohol, or about ten times the total pre-war consumtipn for all purposes. If, with a view to a substantial conservation of petroleum, the admixture of as much as 20 percent were required, the quantity of alcohol would be between four and five billion gallons.

"Depletion of reserves of petroleum in the United States seems likely at some time in the future to cause a marked increase in the cost of production. When a certain point in costs has been reached, several methods of meeting the situation will be available. These include: Increased importation of petroleum; more complete recovery of domestic petroleum from the ground by various so-called secondary methods; conversion of natural gas into gasoline; extraction of oil from shale; synthesis of oil from coal; domestic production of alcohol from vegetable materials, and foreign production of such alcohol. The relative extent to which these different methods will actually be used may depend primarily on their relative costs, but may be affected materially by government action, influenced by a variety of motives. As the result of such action the use of domestically produced alcohol for synthetic rubber, and still more for motor fuel, might conceivably become very large. Far-reaching problems would, however, be involved as regards the quantities and costs of the raw materials required for any great expansion in such use of alcohol."

Synthetic Fuel Research Authorized by House

With little opposition, the House on February 16 passed legislation authorizing the Interior Department to undertake a $30,000,000 research program in the production of gasoline from coal, oil shale and agricultural and forestry products.

The House approved the legislation by a vote of 140 to 113 after defeating efforts to reduce the expenditure to $5,000,000. Although originally contemplated to cover only hydrogenation of coal, amendments were accepted providing for the construction of one or more demonstration plants to produce fuel from oil shale and agricultural and forestry products, and another which would limit the discretion of the Secretary of the Interior and make the development of the project subject to the approval of congress.

In a letter to Representative Jennings Randolph of West Virginia, author of the bill, Administrator Ickes disclosed that the RAF is using British-made synthetic fuel in part, and the German and Japanese air forces also use synthetics.

"It is a matter of chagrin to Americans that we do not already have synthetic gasolines, although, fortunately, the dwindling natural petroleum with which this country was blessed has, through heroic measures of American industry, kept our air forces in the sky, our fleet on the seven seas, and our armies on all continents," Ickes said.

"It is not given to me to know how long this war will last, but I believe

we will have enough natural petroleum to finish it. I do not believe we will have enough for another war, and all who study the question think that we will come out of the war to peace with a shortage of domestic natural petroleum.

"We need synthetic liquid fuels now, but we have not got them."

The house bill differs in important respects from legislation passed by the Senate last November on the same subject, but it is expected no difficulty will arise in reaching an agreement between the two chambers.

At the Interior Department, officials said they were prepared to begin their planning for the synthetic-fuel experiment immediately.

Byrnes Studying Lag in Synthetic Rubber Program

Another investigation of the rubber situation was suggested last month in reports that War Mobilization Director James F. Byrnes was studying the progress of the synthetic rubber program, over the adequacy of which there is a difference of opinion.

Principal headache at the moment is the failure to complete butadiene plants as planned, that phase of the program being about 45 days behind schedule, but there is concern over the prospect that few new automobile tires will be available for civilians for many months to come.

The rubber director claims the synthetic program is moving along satisfactorily, with every prospect that production in the current quarter will meet the estimate of 166,300 tons. But military demands for rubber have increased and what was considered adequate a year ago now threatens to fall short of requirements.

The lag in the oil portion of the rubber program is attributed in part to the high priorities first given grain alcohol plants—the alcohol industry had powerful congressional support—and in part to the fact that three processes were adopted by the oil industry as against a single standardized process for alcohol.

The post-war fate of the rubber program also is said to have exerted some influence. That this is a live subject is evidenced by the exhaustive study into petroleum-alcohol competition made for the House Ways and Means Committee by the Tariff Commission.

Although the Baruch program had been offered as assuring that the United States would be over the hump after the middle of this year, the combined Raw Materials Board on February 25 foresaw that "the situation in 1945 will be further aggravated unless more natural rubber than is now in sight is forthcoming."

The need for mixing natural crude with synthetic rubber for the production of many important items, particularly tires and surgical goods, is creating a strain upon current natural crude inventories, the board disclosed.

Despite the great success to date with the synthetic program and the need for bringing it to maximum production at the earliest possible date, we are consuming natural rubber at a considerably greater rate than we are receiving it from the few sources still available to us," it declared. "Even at the lowest rate to which we can compress natural rubber consumption, supply and requirements of natural rubber will not be in balance."

Standard Samples Of Hydrocarbons

In accordance with the announcement June 1, 1943, by Dr. Lyman J. Briggs, director, work was begun at the National Bureau of Standards on July 1, 1943, on the preparation of standard samples of hydrocarbons of known high purity for calibrating analytical instruments and apparatus in the research, development, and analytical laboratories of the petroleum, rubber and allied industries. In order to expedite the work, and to make available the largest possible number of compounds in the shortest time, only a limited quantity of each hydrocarbon has been prepared and the purity of each has been pushed only to a point that is believed to be amply adequate for the present urgent needs for calibration.

There are now available under this program 15 hydrocarbons, as follows:

Compound	NBS Standard Sample Number	Amount of impurity mole percent
n-Pentane	201	0.25 ± 0.10
2-Methylbutane (isopentane)	202	0.13 ± 0.06
n-Hexane	203	0.24 ± 0.09
2-Methylpentane	204	0.25 ± 0.10
3-Methylpentane	205	*
2,2-Dimethylbutane	206	0.12 ± 0.05
2,3-Dimethylbutane	207	0.06 ± 0.04
Methylcyclopentane	208	0.25 ± 0.09
Cyclohexane	209	0.012 ± 0.007
Benzene	210	0.05 ± 0.02
Methylbenzene (toluene)	211	0.04 ± 0.02
Ethylbenzene	212	0.20 ± 0.07
1,2-Dimethylbenzene (o-xylene)	213	0.14 ± 0.05
1,3-Dimethylbenzene (m-xylene)	214	0.17 ± 0.07
1,4-Dimethylbenzene (p-xylene)	215	0.07 ± 0.03

*Not determined; believed to be the same as for 2-methylpentane.

Each of these hydrocarbons is available at the costs indicated in Pyrex glass ampoules, sealed "in vacuo," in the following kinds and sizes of containers:

Designation to follow Standard Sample Number	Volume of Hydrocarbon	Kind of container	Cost per Sample
—5	5 ml	plain ampoule, sealed "in vacuo"	$3.00
—8S	8 ml	special ampoule, with internal vacuum "break-off" tip, sealed "in vacuo"	$5.00
—25	25 ml	plain ampoule, sealed "in vacuo"	$9.00

Proper designation is illustrated as follows: An order for 8 ml of cyclohexane, sealed "in vacuo" in a special Pyrex glass ampoule with internal vacuum "break-off" tip, would be given as "Cyclohexane, No. 209-8S. Similarly, an order for 5 ml of 2,2-dimethylbutane, sealed "in vacuo" in a plain Pyrex glass ampoule, would be given as "2,2-Dimethylbutane, No. 206-5.

For simplification the cost of the various hydrocarbons has been made the same. Prices are subject to change as conditions warrant. The cost includes delivery under government frank in the United States and to Mexico, Canada, Cuba, and United States possessions. For all shipments to other countries, 50 cents postage must be added for each container, and, in addition, 25 cents for insurance or registration of each shipment.

Samples must be paid for in advance, with order. Money orders, checks, etc., should be made payable to the National Bureau of Standards. Payment for foreign orders should be by an international money order or by a check payable through the New York Clearing House or a bank in the United States.

Orders should be addressed to the National Bureau of Standards, Washington 25, D. C., specifying clearly by number and name the hyrocarbons and containers wanted.

Program of Annual WPRA Meeting Is Announced

The program for the annual meeting of the Western Petroleum Refiners Association, Jefferson Hotel, St. Louis, March 28, will be restricted to one day. The business meeting will take part of the time and there will be four speakers.

W. W. Vandeveer, director, Petroleum Administration for War, District 2, will discuss "Crude for Midwestern Refiners."

Paul C. Ryan, former president of National Petroleum Company, will speak on "Petroleum in the Postwar Period."

Bruce K. Brown, assistant deputy administrator, Petroleum Administration for War, will discuss problems in wartime petroleum refining. A fourth speaker will be announced later.

A luncheon will be served with the compliments of the association to those attending the meeting.

New Pamphlet Combines Natural Gasoline Codes

Natural Gasoline Association of America and American Gas Association have issued a new pamphlet combining their Standard Compression and Charcoal Tests for Determining the Natural Gasoline Content of Natural Gas. The new publication is known as A.G.A.—N.G.A.A. Code 101-43 and replaces Code 101 adopted in 1933.

No changes have been made in the methods themselves as published singly, as they merely have been put in one publication following approval of both methods by American Gas Association.

Single copies of the code are priced at 50 cents each, with lower prices for quantities, and may be had from Natural Gasoline Association of America, 922 Kennedy Building, Tulsa 3, Oklahoma.

Ten SAE Meetings Are Scheduled for 1944

The Society of Automotive Engineers has arranged programs for 10 national meetings in 1944, each directly related to pertinent phases of the SAE War Engineering programs. Purpose of the meetings as explained by John A. C. Warner, general manager, is "mass dissemination of technical data essential to mass production of war materials.

The meetings, listed below, will be held chiefly in war-production centers, so engineers engaged in war work can attend without extended travel:

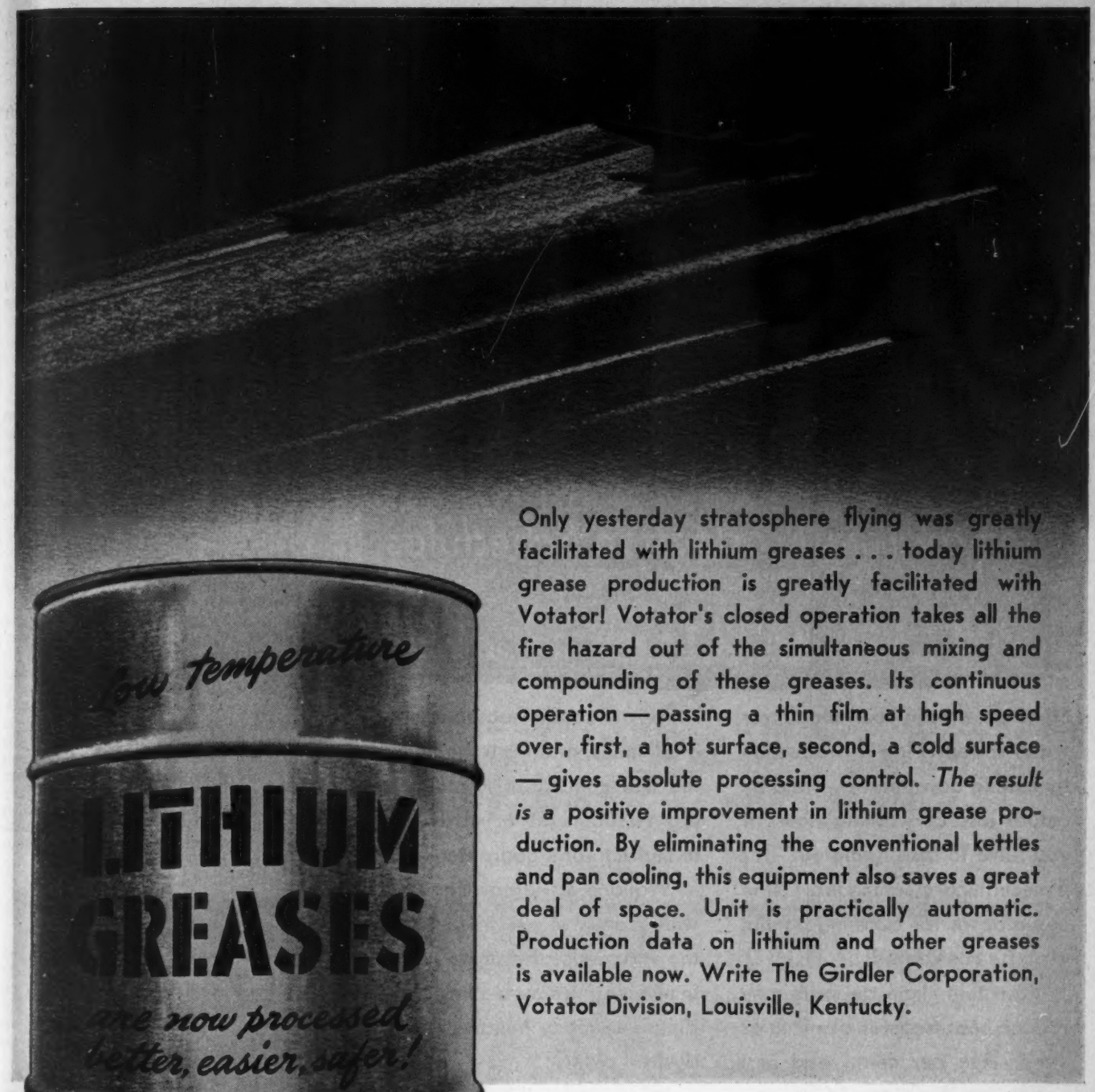
April 5-7, SAE National Aeronautic Meeting, Hotel New Yorker, New York.

May 17-18, SAE National Diesel-Fuels and Lubricants Meeting, Hotel Knickerbocker, Chicago.

June 5-7, SAE National War Materiel Meeting, Book-Cadillac Hotel, Detroit.

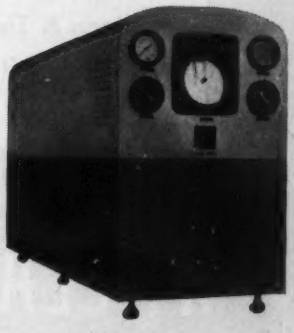
June 28-29, SAE National Transportation and Maintenance Meeting, The Bellevue-Stratford, Philadelphia.

August 24-25, SAE National West Coast Transportation and Maintenance



Only yesterday stratosphere flying was greatly facilitated with lithium greases . . . today lithium grease production is greatly facilitated with Votator! Votator's closed operation takes all the fire hazard out of the simultaneous mixing and compounding of these greases. Its continuous operation — passing a thin film at high speed over, first, a hot surface, second, a cold surface — gives absolute processing control. *The result is a* positive improvement in lithium grease production. By eliminating the conventional kettles and pan cooling, this equipment also saves a great deal of space. Unit is practically automatic. Production data on lithium and other greases is available now. Write The Girdler Corporation, Votator Division, Louisville, Kentucky.

The compact units of Votator Grease Processing Equipment are completely enclosed and self-contained.



THE Votator* GREASE PROCESSING EQUIPMENT

A GIRDLER PRODUCT

*Trade Mark Registered U. S. Patent Office

SLOW DOWNS
in your Cooling Water System

Slime growths in your condenser water seriously lower production by cutting down power—and by actual loss of working hours if you have to take "time out" for a mechanical cleaning job. Often a shutdown for cleaning cannot even be considered.

Even thin slime deposits may reduce heat transfer as much as twenty-five per cent., and cost needless extra tons of fuel.

The Wallace & Tiernan Intermittent Desliming Process will keep your condenser tubes clean at all times, and keep the unit on the line continuously, maintaining vacuums at or above the manufacturer's guarantee.

Wallace & Tiernan Engineers will gladly give you the benefit of the experience they have gained in eliminating severe sliming conditions in many hundreds of industrial plants.

Why not let them make recommendations to meet your individual problem?

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WALLACE & TIERNAN
PRODUCTS · INC.
Manufacturers of Chlorine and Ammonia Control Apparatus
Belleville 9, New Jersey • Represented in Principal Cities

Meeting, Multnomah Hotel, Portland, Oregon.

September 13-15, SAE National Tractor Meeting, Hotel Schroeder, Milwaukee.

October 5-7, SAE National Aircraft Engineering and Production Meeting, Engineering Display, Hotel Biltmore, Los Angeles.

November 9-10, SAE National Fuels and Lubricants Meeting, Hotel Mayo, Tulsa.

December 4-6, SAE National Air Cargo Meeting, Hotel Knickerbocker, Chicago.

The society's annual meeting has been scheduled for January 8-12, 1945, in the Book-Cadillac Hotel at Detroit.

Natural Gas Statistics Set Forth in Bulletin

The Federal Power Commission has announced publication of a new 87-page report entitled "Statistics of Natural Gas Companies" containing financial and operating information on 118 gas companies which reported an aggregate book investment in gas plant of $1,759,882,373 as of December 31, 1942. This is the first such report issued by the commission and was compiled as a part of the Commission's administration of the Natural Gas Act

The report is similar in make-up and content to the commission's annual series entitled "Statistics of Electric Utilities" which has become a standard reference work for electric utility management, regulatory agencies, banks, investment houses, and students of the industry. "Statistics of Natural Gas Companies, 1942" is priced at 50 cents a copy and may be obtained only from the Federal Power Commission, Washington 25, D. C., to which all orders should be addressed enclosing remittance. In ordering, the new publication may be referred to as FPC S-33.

Post-war Surplus Handling Being Carefully Planned

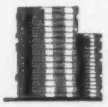
Large quantities of oil products which are expected to be declared surplus by the military services as our battle fronts lessen in number will be disposed of by the Treasury procurement division under plans in the making of which the industry will have a voice.

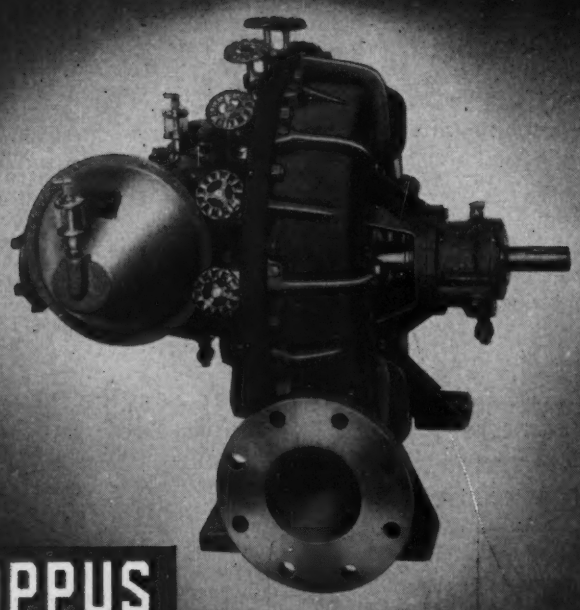
Treasury officials thus are following recommendations of Congressional committees which have studied post-war conversion problems, that in the disposition of surplus material every possible effort be made not to glut markets so as to handicap the return of industry to peacetime operations.

Few problems of any magnitude are foreseen in disposing of such surpluses as may occur between now and the end of the war, because of the shortages of supply and civilian need for many of the products which will be involved, but even the few problems that do arise will be minimized by a decision of the department to dispose of its materials in accordance with the regulations of the War Production Board, Office of Price Administration, Petroleum Administration for War and other control bodies.

After the war, it is planned to make a continuous study of probable surpluses, civilian shortages and the length of time it will take industry to reconvert to the production of each type of commodity.

A tentative program has been worked

A steam turbine needs a big frame to develop Elephant Power . But if you need only Horsepower, a **COPPUS** Steam Turbine saves money and metal . Six sizes from 150 Horsepower down to fractional. Each smaller size has smaller frame requires less metal and is priced less . Each is a COPPUS Blue Ribbon Turbine so you get top quality while saving money  and metal .



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DESIGNED FOR YOUR INDUSTRY...ENGINEERED FOR YOU

COPPUS TURBINES

Save Metal in Wartime — Will Save You Money in Peacetime

Like all Coppus "Blue Ribbon" Products (blowers, ventilators, gas burners, etc.), the small H.P. steam turbine is a precision-made product . . . controlled by Johansson size blocks . . . and every turbine is dynamometer-tested before shipment. 85% of all orders since 1937 have been repeat orders.

Write for Bulletin 135-9

COPPUS ENGINEERING CORPORATION
613 Park Ave., Worcester, Mass.
Sales Offices in THOMAS' REGISTER
Other "Blue Ribbon" Products in REFINERY CATALOG.

It's important to

ISOLATE FIRE

A fire that spreads may bring tragic results — machinery and equipment damaged or destroyed . . . valuable goods ruined . . . precious man-hours lost . . . production at a standstill.

"Automatic" FIRE-FOG is the antidote for fires and fire spread due to ignited oil or other flammable liquids. Its mist-fine water spray *automatically* envelops and "rings" the fire *right at point of origin.* So quickly does FIRE-FOG respond that the fire is blanketed, isolated and quenched, usually in a matter of seconds. Significantly, only the FIRE-FOG Nozzles that "guard" the burning area go into action. For FIRE-FOG concentrates on the fire—no other area is affected.

YOUR KIND OF FIRE! "Automatic's" Proving Ground is a fire-testing laboratory. Here *your* kind of fire hazard is reproduced and the fire protection system best for you is put to test. You *know* before you buy. An "Automatic" Engineer will give you the complete details—no obligation.

"AUTOMATIC" FIRE-FOG

★ IT BLANKETS
★ IT ISOLATES
★ IT QUENCHES

"AUTOMATIC" SPRINKLER CORPORATION OF AMERICA ★ YOUNGSTOWN, OHIO

★ ★ ★ OFFICES IN PRINCIPAL CITIES ★ ★ ★

"AUTOMATIC" SPRINKLER CORPORATION OF AMERICA RATE OF RISE TRADE MARK REG. U.S. PAT. OFF.

out for petroleum products, of which large inventories of lubricating oils, greases, fuel oils and gasoline are expected to be available eventually. Some of this will be in specially marked and coded government containers unsuitable for direct sale to consumers, and much of it may have to be reprocessed for use in civilian equipment, but it is planned to sell it under OPA and PAW regulations to the commercial trade, with consideration for programs of the Office of Civilian Requirements and WPB.

Mineral Oil, Wax Standards Published

The American Standards Association has recently added two new standards to the list of almost 50 standards in the field of testing petroleum products and lubricants. Both of these standards, Standard Method of Test for Carbonizable Substances in White Mineral Oil (Liquid Petroleum) (Z11.49-1943) and Standard Method of Test for Carbonizable Substances in Paraffin Wax (Z11.50-43), have been developed by the D-2 Committee on Petroleum and Lubricants of the American Society for Testing Materials.

The standard method of test for carbonizable substances in white mineral oil is applicable to white mineral oil to ascertain whether it conforms to the standards of quality required for pharmaceutical use.

The standard method of test for carbonizable substances in paraffin wax is applicable to paraffin wax to ascertain whether it conforms to the standard of quality required for pharmaceutical use.

Both standards may be obtained for 25 cents each from the American Standards Association, 29 West 39th Street, New York 18, New York.

Serial Coupons to Strike At Black Market Tactics

Adoption of serially-numbered coupons for B and C gasoline rations is the latest device of the Office of Price Administration to combat black-market operations. The numbered coupons, proven effective with T rations, come in rolls like movie tickets, from which they are torn off and stapled in a cardboard cover for individual rations. Under the former plan, coupons came in sheets and were "tailored" for each application, the coupons torn off becoming waste which, in some instances, found its way into the hands of motorists.

The numbering of coupons will also identify stolen ones which may be taken to a different section of the country for sale or use.

Cities Service Plant Makes Long Run

The continuous operation of Cities Service Oil Company's isomerization and alkylation units at East Chicago, Indiana, for a period of nine months has created considerable interest among petroleum technologists. The two units, which are producing components of 100-octane gasoline, were put into operation last May.

The conversion rates and catalyst efficiency records established by the isomerization units are among the highest in the industry and their operation has been studied by users of similar processes in this and allied countries.

---to control both units of the Port Neches Butadiene Plant!

IN designing the world's largest butadiene plant, the Neches Butane Products Company faced one of the toughest control jobs ever tackled. Even the initial step of obtaining pure normal butylene was complicated by the hairline differential between its boiling point and those of accompanying hydrocarbons.

Foxboro Instruments were specified for the vast majority of control jobs in this plant . . . and were assigned WPB priorities among the highest of any wartime projects! More than 320 Foxboro Instruments, including 272 Stabilog Controllers, now automatically control this operation, from the input gathering pipelines to the final delivery of purified butadiene!

This important new installation is merely another example of the petroleum industry's preference for control systems based on the famous Stabilog Controller. For more than 15 years, Foxboro's Stabilog Controller has been the leading stabilizing controller.

Today, with the additional refinement of HYPER-RESET, Stabilog Controllers deliver process stability never even approached before!

Write for detailed Stabilog Controller Bulletin A-330. **The Foxboro Company, 74 Neponset Ave., Foxboro, Massachusetts, U. S. A.** Branches in principal cities.

Every step in the flow through this plant is handled by automatic control instruments. Foxboro supplied the majority of these instruments . . . over 320, in all.

by FOXBORO

REG. U. S. PAT. OFF.

ARMY E NAVY

Pan American Completes Aviation Gasoline Facilities

CONTRIBUTIONS of refining technology to the expansion of petroleum resources were stressed in the program of dedicating 100-octane aviation gasoline facilities of the Texas City plant of Pan American Refining Corporation, March 9. A program at the plant in the afternoon was followed by a banquet before the Galveston Chamber of Commerce, when Dr. Robert E. Wilson, president of the company, spoke on "Technology as a Multiplier of Our National Resources."

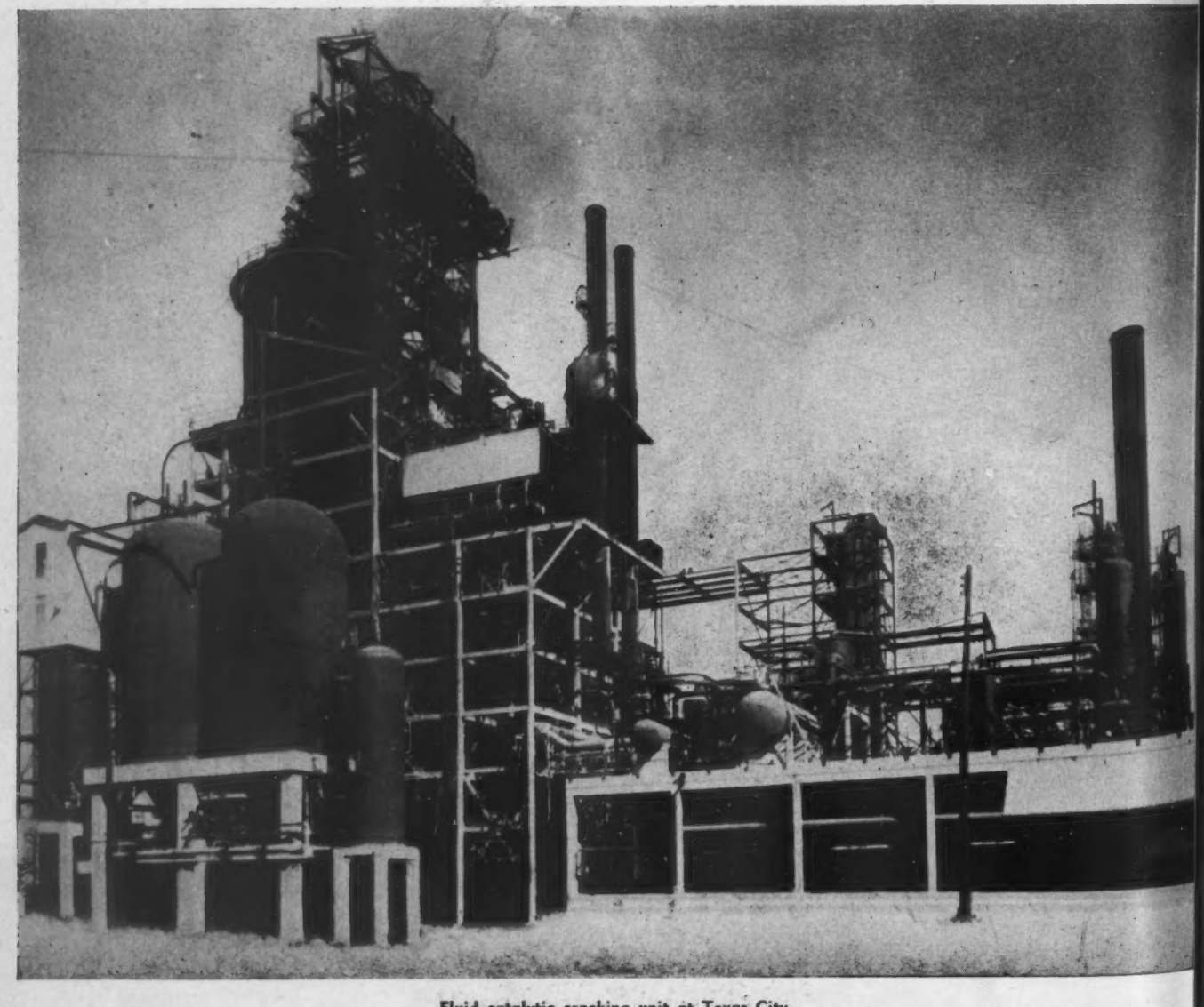
The dedication program at Texas City was staged near the new fluid catalytic unit, which recently was put on stream. The new alkylation unit and new power plant are other additions of recent completion. P. J. Sweeny, plant manager, introduced D. J. Smith, vice president, who in turn introduced F. E. Johnson, vice president of The M. W. Kellogg Company, designer and contractor of the unit. Dr. Wilson spoke briefly at the dedication and introduced military personnel, state and national officials.

The radio broadcast of Major George Fielding Elliott concluded this ceremony.

At the banquet Dr. Wilson dealt briefly with the contributions of technology to increasing crude oil reserves and of its role in refining said:

"Of fully equal importance from the standpoint of getting the most out of our natural resources, have been the amazing developments in refinery technology since 1918. In this field there was an important forerunner, visible in 1918, in the Burton cracking process which contributed substantially to the unprecedented yield of 25.3 percent of gasoline from crude oil. More important than this was the fact that the development of the cracking process first awakened the refining branch of the industry to the realization that it was fundamentally a chemical industry and that its future did not consist in merely taking just what came out of the ground and separating it for the markets. Large cracking royalties, whether received or paid, constituted the greatest stimulus to research any industry has ever known. In 1918 there were less than 200 technical men engaged in research in the petroleum industry. Compare this with today's figure of 8 to 10 thousand and you see both the principal cause and one of the effects of the contributions of technology to our industry during the last quarter century.

"Tremendous improvements in the art of cracking, beyond anything which could have been dreamed of in 1918,



Fluid catalytic cracking unit at Texas City.

The two Worthington Feedwater Deaerators, shown at upper left, and among the largest ever built, help produce 50,000,000 lbs. of steam per day for Neches Butane Products Company.

AT PORT NECHES, WORTHINGTON EQUIPMENT SAFEGUARDS CONTINUOUS OPERATION

Two Worthington Feedwater Deaerators with a three million pound per hour total capacity, are now helping provide round-the-clock process steam at the new Port Neches butadiene plant.

To guard against costly delays for maintenance, boilers must be dependably protected from corrosion by the removal of dissolved oxygen from feedwater. As well as doing this job, Worthington Feedwater Deaerators utilize steam to heat the feedwater.

WORTHINGTON PUMPS ARE VITAL LINKS BETWEEN PLANT UNITS

Throughout the entire Port Neches development—unique in industrial history—Worthington centrifugal pumps keep process liquids moving, from the five refineries supplying butane-butylene mixture to the butadiene plant, throughout the butadiene plant itself, and finally pumping the butadiene on to the two copolymerization units where the finished rubber is made.

Worthington congratulates leading oil companies, now operating the government-owned Port Neches butadiene plant, on successfully overcoming the inevitable difficulties of placing such an unparalleled project "on stream" . . . another example of American Industry teamed up to operate, cooperatively and without compensation, in government financed war production.

The Port Neches plant will provide 1/7th of all butadiene required for the nation's 800,000 ton-a-year synthetic rubber program. Port Neches is also another example of Worthington at work to put more *worth* into every tax dollar and War Bond.

WORTHINGTON PUMP AND MACHINERY CORPORATION, HARRISON, N. J.

DISTRICT OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES

BEHIND THE NAME WORTHINGTON

Centrifugal Pumps
Steam, Power & Rotary Pumps
Turbines & Turbo Generator Sets

Angle Gas-Engine Compressors
Diesel, Gas & Convertible Engines
Refrigerating & Dewaxing Equipment

IC4-7

steadily increased the yield of gasoline to around 45 percent in 1941. Since that time the need for producing maximum quality and quantity of war products has slightly reduced the yield of gasoline per barrel of crude.

"The outstanding development of recent years in this field is, of course, catalytic cracking, exemplified by the large unit just completed at Texas City. The new art of catalytic cracking will probably exert as large an influence on the quantity and quality of future gasoline as did the original Burton thermal-cracking process. If the catalytic units already built or building in the United States were used in such a way as to make a maximum yield of high-quality automobile gasoline without shutting down other cracking units, the average gasoline yield could be increased to about 57 percent. As a matter of fact, the only remaining limitation to the yield of gasoline obtainable from a barrel of crude, by processes already fully developed, is the public demand for other products whose economic value is close to that of gasoline, namely, kerosine, lubricants and household fuels. This fact in itself should put a higher postwar value on every barrel of crude in the United States because it will no longer be necessary to produce a large by-product of heavy fuel which would have to compete with coal. However, these uses of heavy fuel which can stand a moderate premium above the cost of coal undoubtedly will continue to be supplied, either by the older type of refineries or by the importations of heavy foreign crudes or fuel.

"Cracking is, however, only one of many new processes which have made important contributions to the yield and quality of modern motor fuel. Polymerization processes now make many thousands of barrels daily of high-quality gasoline from refinery gases which in the past were wasted or burned as fuel. By modification, these processes have contributed heavily to the production of 100-octane gasoline. Alkylation is a brand new development of the past few years which converts other gaseous constituents into high-quality gasoline. The reaction, while simple on paper, was not even considered possible a dozen years ago, yet it is today the backbone of our tremendous production of 100-octane gasoline. Hydroforming, hydrogenation, isomerization and many other long-haired additions to the family of chemical processes used by our refineries, have come out of our research laboratories to make major contributions to the air superiority which is so largely responsible for our present situation in the war. Tetra-ethyl lead is another outstanding development of the past quarter century making for better anti-knock gasoline and that, too, grew out of research started during the last war.

"Due largely, though not entirely, to improvements in the quality of gasoline and lubricating oil, the modern aviation engine is about ten times as powerful, weighs about a quarter as much per horsepower, and has about 40 percent greater thermal efficiency as compared with those of the last war. These factors have increased the load-carrying ability, range and performance of military planes far beyond anything dreamed of even a dozen years ago. Similar improvements in motor gasoline have made possible increasing the average compression ratio of automobile engines by over 50 percent—though most of this gain has been taken in the form of better performance rather than greater average mileage on the road. And technology has also been the principal factor in the major price reductions since 1918.

"Despite the outstanding accomplishments of the new oil-finding and producing techniques which I previously discussed, if it had not been for the developments in refining technique we would not today have half enough crude oil to meet our gasoline demands, and the quality would be such that modern automobiles, let alone modern airplanes, could not even operate.

What of the Future?

"Of course, confirmed pessimists, on reviewing these achievements can still say: 'But these are all discoveries that have been made once and hence cannot be made again—whence will come our new methods of finding and refining petroleum?' The only answer I can give is that they will come from the same research and development organizations which have achieved these results during the past quarter of a century. I cannot predict even the nature of most of these coming developments, any more than could the scientists of 1918 have guessed at what we have seen, but I do know that we have about fifty times as many research workers as in 1918 and that they have not lost their ingenuity. Many important developments are bound to result from the scientific work of this war, just as occurred after the last war. Large new areas of potential oil territory are being intensively explored for the first time, and some of them already show real promise. Even larger areas in nearby countries have major potentialities of supplementing our own resources as the need arises.

"One possibility which seems certain to develop rapidly after the war is the synthesis of gasoline from natural gas, of which our proven reserves, measured as total heating value, are nearly as large as those of crude petroleum (though much of these gas reserves are dedicated to other purposes). Of course, our known reserves of tar sands, oil shale, and coal are each enormously greater than those of oil and better methods of handling and making refined products from these sources will gradually be worked out, but they will not become commercially important until crude and product prices are substantially higher than at present.

Need for Conservation

"While I feel that all these factors give us adequate grounds for optimism as to the future of our industry and those dependent on it, I trust that nothing I have said will imply lack of need for increasing our efforts toward sound conservation practices in every branch of our industry. For one thing, technology has not only multiplied our supplies of oil, but has also multiplied its uses in making rubber, plastics, explosives, and dozens of other high-value products which are today made from petroleum. If we do not use effectively the means science has supplied to make conservation possible we are not worthy of either the resources or the technology with which we have been so generously endowed. Yet it is a deplorable fact that some important producing states do not yet have adequate conservation laws, and that an inflexible price policy is causing small wells to be shut down every week, and is delaying the introduction of secondary-recovery operations in many fields.

"In the future, designers of automotive equipment should, and I believe will, place more emphasis on economy. To date most of the improvements in gasoline quality and engine design have been used to make possible roomier and heavier cars, and more flashy performance, so there is much room for conservation in this field, especially in view of the better, but somewhat more costly, gasolines which will be available postwar. Slightly higher compression ratios, lower car weights, and more extensive use of automatic transmissions geared for economy could easily increase car mileage by 30 percent without any considerable increase in cost or decrease in performance.

"The day is probably also here when heavy fuel oil should no longer be sold on the basis of straight price competition with coal for use in larger power installations, but in cases where factors of cleaniness, convenience, and labor-saving are important, fuel oil can continue to be supplied as a by-product from non-catalytic cracking operations and by importation. The current shortage of household fuel has already stimulated more efficient use thereof in most homes, and there seems no reason to doubt the adequacy of future supplies of this product, which means so much to the comfort of home owners.

"Increasing importation of heavy fuel and asphaltic crudes seems desirable in order to keep our coastal industries and shipping supplied with heavy fuel at reasonble prices, and at the same time encourage American refiners to convert domestic crudes into maximum yields of gasoline and other light products. However, if such importation is to aid and not hurt the conservation of our own reserves, it must be managed so as not to keep domestic crude prices below the point which will encourage the search for new oil pools, the continued operation of stripper wells, and at the same time maximize secondary-recovery operations and many other conservation practices. Any sound national oil policy must recognize these essenial facts, and be based on sound technology, rather than on theory and political expediency.

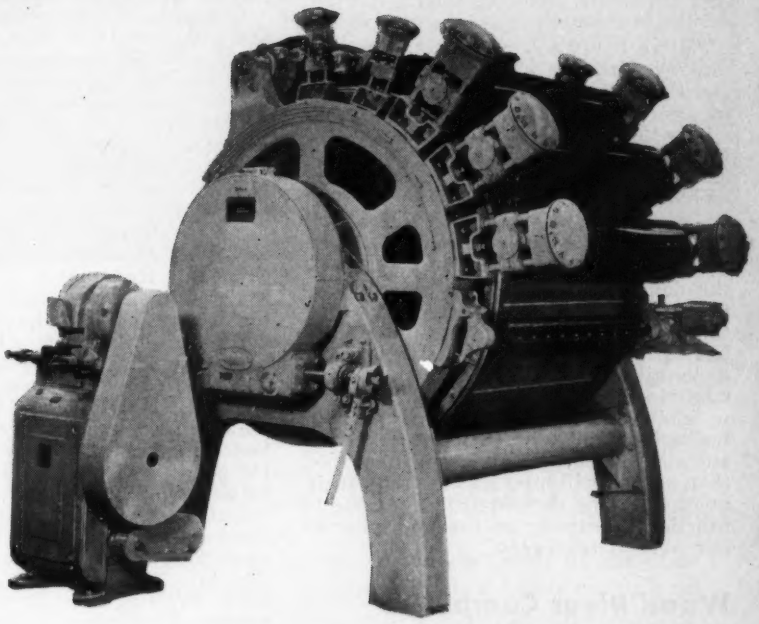
Threats to the Future of Research

"As a matter of fact, to my mind the most serious and imminent danger to the future of our industry is not the possible shortage of satisfactory raw material, but lies in certain threats to the future of the very research and technology which is, as I have shown, the indispensable multiplier of our natural resources. Demands in certain quarters for regimentation and government domination of research, if yielded to, could easily devitalize our whole research program. Equally serious are the attacks on our patent system, without which we would not only lose much of the incentive to research, but most of those who did continue their research would revert to the dark ages of secret processes and cease prompt publication of their discoveries. Such action would tremendously retard the progress of science. A patent is primarily a reward for prompt and full disclosure so that the whole scientific world can progress in the light of the latest information in any given field. The resultant tempo of research and invention in America has made us the envy of the whole world.

"Political attacks on patents urge that their abolition will aid small companies,

. . . AND MANY OLIVER SYNRUB FILTERS

next door helping to turn this raw material into synthetic rubber



Silhouetted against the skyline at Port Neches is graphic proof of the genius of American Chemical and Petroleum Engineers. For here is the largest synthetic rubber center of the world. A forest of towers to turn out the butadiene and next door a huge synthetic rubber plant to complete the processing!

In the rubber division of the project nearly a score of Oliver Synrub Filters are washing and dewatering the coagulated latex. This filter was developed by Oliver United engineers especially for the synthetic rubber industry after months of research and testing. To the new problems encountered, they brought the experience gained from serving the process industry for more than thirty-five years and from observing the work being done by some 16,000 Oliver United Filters of different types throughout the world.

Coupled with unquestioned technical talent, Oliver United can offer many types of filters in both the vacuum and pressure groups from which to select. Or, as in the case of the Synrub Filter, new types are developed. The petroleum industry, no matter what direction it may take in the future, will continue to find in Oliver United the broad-gauged, experienced engineering and manufacturing service needed to solve its filtration and clarification problems effectively.

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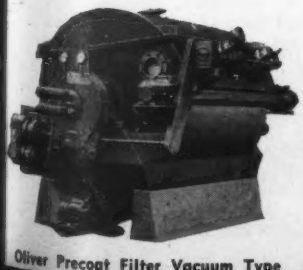
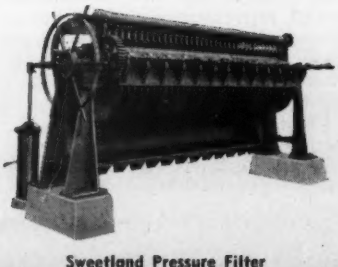


Oliver Precoat Filter Vacuum Type



Sweetland Pressure Filter

Kelly Pressure Filter

Oliver Pressure Filter

but this overlooks three vital factors: First, many of our most important companies could never have survived their early years had not patents given them protection from larger competitors who would have copied their inventions and outsold them due to being better known or having wider distribution. Second, many small companies could not finance their relatively large research programs and keep in the forefront of competition were it not for income received from licensing their patents to others. Third, many small companies prefer to minimize their own research and development expenditures and use whatever turns out to be the best processes developed by any of their competitors on a reasonable royalty basis, complete with all the knowhow. Emasculation of our patent system would do far more hurt to small than to large companies who could afford to continue their research regardless of patents, and keep their important results to themselves as long as possible.

"Were it my job as supersaboteur to destroy America's future greatness, I can think of no more effective way than to destroy our patent system. The tragedy is that if we permit impractical theorists and faddists to distort the facts and hypnotize our nation into this act of hara-kiri, all of us will suffer and yet no adequate punishment can be meted out to those really responsible.

"In other words, both the hope of and the danger to America lie more in the field of mind than of matter. The only thing that can prevent our country from having abundant liquid fuel for many generations, at reasonable prices—certainly lower than those of 25 years ago—is interference with the free play of technology and competitive enterprise. I am still enough of an optimist to feel that sanity will prevail and that technology will be permitted to continue to function effectively as the multiplier of our natural resources."

Wood River Completes Fluid Catalyst Unit

The fluid catalyst unit of Standard Oil Company (Indiana) was on stream several days previous to its acceptance, February 28, from the M. W. Kellogg Company, contractor. Information made public by the contractor gives these details:

"As is customary in these fluid-catalyst cracking units, the heated catalyst is continuously fed to a pre-heated oil stock. The principal innovations consist of the installation of a pre-heater furnace, the regenerator being installed as an overhead unit, and the reactor being of different design to increase capacity for severe gasoil cracking. This unit also varies from the usual Kellogg design in that the two large vessels are upheld on skirts from the ground up, instead of being supported by the main structure.

"Over 12,000 tons of material were required for this unit, exclusive of 6100 yards of concrete in the foundations and literally miles of aeration piping and stream tracing were installed. At the peak of construction, nearly 1000 men were employed and work was carried on two 12-hour shifts for 7 days per week, over a long period. The two large vessels are Class 1 design and were completely fabricated in the field. Much of the welding involved plate 2¼ inches thick and seams were completely X-rayed to insure their quality."

Natural Gasoline Association Program Includes Look Into Postwar Operations

For the second successive year a question-and-answer panel will be a part of the program of the annual meeting of the Natural Gasoline Association of America, which meets in the Baker hotel, Dallas, April 12, 13 and 14. This year the panel will make up the program of both morning and afternoon sessions of the final day. Its purpose is:

"To provide a forum where executives and technical men of the natural gasoline and condensate industries can question the leading authorities on processing, production and operating trends with a view to obtaining guidance for present and future operations."

Questions will be prepared in writing and will go to D. E. Buchanan, president of Hanlon-Buchanan, Inc., Tulsa, who will serve as "interlocutor." A committee will pass all questions to him. Its members are H. W. Harts, Warren Petroleum Corporation, Tulsa; B. R. Carney, Shell Oil Company, Tulsa; R. G. Atkinson, Shamrock Oil & Gas Corporation, Amarillo; I. Earl Nutter, Hagy, Harrington & Marsh, Amarillo; W. W. McNeal, Jr., J. S. Abercrombie Company, Houston.

Those invited to serve on the panel for answering the questions include: Gustav Egloff, Universal Oil Products Company, Chicago; John Ford, The M. W. Kellogg Company, New York; A. H. L. Hutchinson, The Fouor Corporation, Los Angeles; M. F. Kotzebue, Gasoline Plant Construction Company, Houston; P. M. Raigorodsky, Petroleum Engineering, Inc., Tulsa; Henry Wade, Stearns-Roger Manufacturing Company, Denver; James E. Pew, Petroleum Administration for War, Washington; D. P. Barnard, Standard Oil Company (Indiana), Whiting; E. D. Cummings, director of refining, PAW; Dr. G. G. Brown, University of Michigan; E. O. Bennett, consulting engineer, Houston; R. C. Alden, Phillips Petroleum Company, Bartlesville; Stuart Buckley, Humble Oil & Refining Company, Houston; P. S. Magruder, General Petroleum Corporation, Los Angeles.

The first two days of the program have been prepared for the purpose of making the annual meeting a "War Products and Postwar Planning Conference.

The subjects and speakers listed for the tentative program are:

Wednesday, April 12, 2:00 P.M.

"Time," by N.G.A.A. President James W. Vaiden, vice president of Skelly Oil Company, Tulsa.

"Why and Where to Build a Natural Gasoline Plant," by Frank Matheny, Superintendent of Natural Gas and Gasoline Department, Phillips Petroleum Company. (This paper will review the many factors which should be considered before a plant is built, including analysis of reservoir fluids, estimates of fluid and gas reserves, possibility of pressure maintenance and repressuring, effect on plant design, etc.)

"Infrared Spectograph Analysis of Natural Gas Hydrocarbons," by H. Cary, National Technical Laboratories, Pasadena, California. (Without delving too deeply into the complex mathematics of the method, this discussion will present the possibilities for accurate and quick evaluations.)

"Centrifugal Compressors and Their Application in Natural Gas and Natural Gasoline Operations," by E. O. Bennett, Engineering Consultant, Houston. (A complete review of the development of this device to its present practical stage and its possibilities for handling high pressures and large volumes of natural gas, with some comments on gas turbines.)

Technical Committee Report, by M. R. Church, Shell Oil Company, Inc., Houston. (Covering work by that group on fractional analysis, hydrocarbon constants, L.P.G. Sulphur determination, etc.)

Thursday, April 13, 10:00 A.M.

"The Future of Liquefied Petroleum Gases." (This paper is to be a symposium of opinion as to the supply of these products in: 1, Balance of the War Period; 2, Immediate Postwar Period; and 3, Three to Four Years of Peacetime Developments. Companies contributing include: Carbide & Carbon Chemicals Corporation; Cities Service Oil Company; Lone Star Gas Company; Phillips Petroleum Company; Shell Oil Company; Skelly Oil Company; Standard Oil Company of California; and Warren Petroleum Corporation.

Address — James E. Pew, Director, Natural Gas and Natural Gasoline Division, Petroleum Administrator for War, Washington, D. C.

"Catalytic Cracking, Asset or Menace to Natural Gasoline Operations," by D. P. Barnard, Associate Director of Research, Standard Oil Company (Indiana), Whiting, Indiana. (With the predicted cut-back in 100-octane aviation fuel after the war, will the huge refining plants built for the purpose have an excess of light ends or will refiners still need natural gasoline. A broad discussion of possible postwar fuel requirements, economics and supply and demand as influenced by modern, war erected, refining plants.)

Presentation of the Hanlon Award.

Afternoon Session, 2:00 P.M.
High Pressure Gas Session

"Unitization of Condensate Pools," by Roy L. Benoit, Ohio Oil Company, Shreveport. (A discussion of the legal and contracting difficulties in drawing of unitization agreements.)

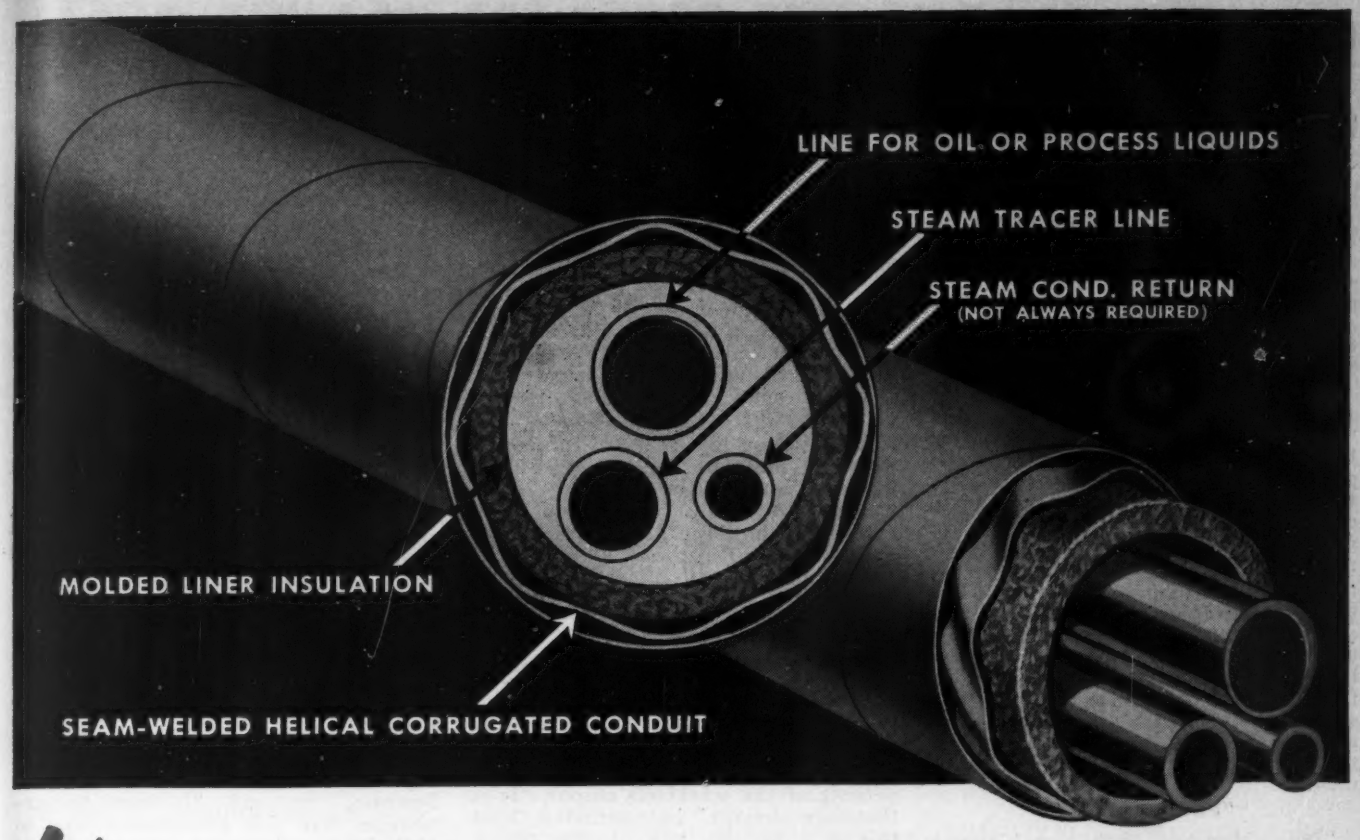
"Operating Economies of Unitization," by Jack Flaitz, Distillate Production Corporation, Houston. (The great savings in investment and operating as well as the conservation of natural resources.)

"Condensate Gas Sampling," by Dr. G. G. Brown and Dr. D. L. Katz, University of Michigan. (A report of the cooperative field experiments conducted by these men in the Katy field of Texas under the sponsorship of N.G.A.A., and recommending a standard method for obtaining a representative sample of two-phase natural gases.)

Discussion by Kenneth Eilerts, Senior Chemist, United States Bureau of Mines, Bartlesville.

Friday, April 14

"Information Please" session.



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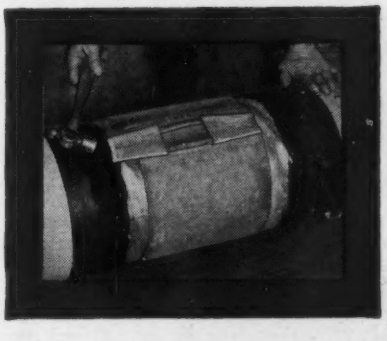

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PIWC Issues as "White Paper" Charges Of "Fascist Approach" Against PRC

Following up its attack on Petroleum Reserves Corporation, the Petroleum Industry War Council early last week issued as a "white paper" the report prepared for the Independent Petroleum Association by George A. Hill, Jr., on foreign policy, which was approved by the council at its March meeting.

Bristling with charges of "the fascist approach," "secret maneuverings" and "power politics," the report analyzed the United States' foreign oil policy in the past and compared with it new policies which it charged PRC is attempting to put into effect, and, the council said, "reflects the opinion of the petroleum industry generally."

Assailing the Saudi Arabian pipe-line project, the report characterized PRC's activities in that field as "the fascist approach—the cooperative state, with its lust for imperialism—the shackling of free American enterprise, not to better serve, but to displace private enterprise, at not only the risk, but with the certainty, of international political involvement.

"Power Politics"

"It is a sign-post of the new highway of international power politics not yet revealed to and approved by the Senate of the United States as an international commitment entered into with 'the advice and consent of the Senate,'" it was declared.

"A comparison of the new fascist, or corporative state approach to the postwar world indicated by the direct engagement of the United States government in the oil business and probably in other phases of private business in defiance of the American way of life for which we are fighting this war parallels the almost fatal new departure in foreign policy made at the end of World War I, in the decision to scrap our then new and building battle fleet at the Washington Naval Conference.

"It will be a mistaken policy no less portentous than the scrapping of the fleet, because it is the scrapping of the internal strength of America itself.

"It represents a new philosophy that we, a democratic people, having girded our sinews of war successfully on the basis of private enterprise and the American way of life, must needs revert to the hated procedure of the nazis and fascist in our postwar world and commit to government (in fascist fashion) direct engagement in the conduct of private enterprise, in surrender of freedom and the American system of free private enterprise."

The introduction of PRC into the government organization, Hill revealed, focused the attention of oil men throughout the country on the question of foreign policy.

"The secrecy surrounding the creation of Petroleum Reserves Corporation, the implication arising from the name ascribed to it, its vast charter powers, the amendments to its charter, the composition of its directorate, the conflicting reports with respect to its non-activity, on the one hand, and its varying activities on the other hand, and the non-disclosure of its purposes and objectives by authentic sources over a period of months, provoked widespread discussion and speculation," he said.

"As a result, members of the oil industry, in common with our citizenship in general, became increasingly interested not only in United States foreign policy in general but also United States foreign oil policy in particular."

Hill charged that the PRC project is definitely indicative of "an inter-allied postwar dispute in the very midst of the present war."

None of the three Axis powers owns any oil reserves in the Middle East, he pointed out, but all reserves, refineries and facilities are in the exclusive possession of Allied nationals—American, British, Dutch and French.

"So," he asserted, "it is not a problem of elimination from the Middle East of the aggressor nations."

Further, he explained, Iraq, Iran, Bahrein and Saudi Arabia combined produced last year but little more than 4 percent of the world oil output. "It is therefore obvious," he concluded, "that this is a division and dispute among allies, not in the field of future collective security but in national commercial rivalry wherein opposing allied interests are being arrayed, one against the other."

If the United States is "legitimately concerned" about the future availability of oil belonging to its nationals in this area during the postwar era and for the next world war, Hill suggested, our present national concern be as to what nations are expected to be bound to us as allies in the next war, with what nations are we to make agreements for collective security, in what areas will the United States undertake to enforce an enduring peace by military and naval policing end, if any area is to be under our military protection, what can be secured in the way of naval, air and military bases in strategic locations.

"The American public is confidently expecting the President to submit all international agreements to the Senate of the United States for its consent and approval," Hill asserted. "It hardly expects Petroleum Reserves Corporation to arrogate to itself the functions of the President and/or the Senate."

The industry's charges were answered by Ickes in a radio address March 7, in which he declared that by failure to develop the Middle East concessions now "we will be jeopardizing the future of our country and impairing its prosperity and well-being."

This is one of three aims which should be prosecuted with all vigor, he said, the other two being to find more oil in this country and to learn as much as possible about making oil from coal and shale.

It is the American participation in the Middle East oil fields in the future which gives him concern as a public servant, Ickes said. And, he added, while some may seek to create the impression that the government and the oil industry are arraigned on opposite sides on the pipe-line proposal, "actually the oil industry is itself divided" and "those private interests which stand to benefit for themselves oppose it. For myself, as a representative of the public, I am interested in doing what we can the better to assure this nation's oil future."

The PRC head referred to charges that the pipe line is a "fascist undertaking," pointing out in reply the conservative nature of its directors—Secretary of State Hull, Secretary of War Stimson, Secretary of the Navy Knox and Foreign Economic Administrator Leo Crowley.

"No policy has been arrived at and no act undertaken by PRC without full discussion and the unanimous action of this highly conservative board of directors, everyone of whom believes in American initiative and free enterprise with all his heart," he said.

Declaring that activities of the agency purposely have been restricted to areas outside of the United States, so there can be no interference with the domestic oil industry, Ickes briefly outlined the highlights of the pipe-line contract and asserted that "I do not believe that any one could question the soundness of this agreement from a financial standpoint.

"As to the charge that the project will put the government into the oil business," he said, "I want to emphasize that this government has no such desire and no such intention. While it is the purpose to complete this pipe line and thus make it possible for three American companies to enter the markets of the world on a free and competitive basis, which is their right, the PRC will have no voice in the business policy of any one of the three companies.

"We would own no stock; we would have no representative on any of the boards of directors; we would have no one on the staff of any of the three companies. How then can it be alleged seriously that by building a pipe line we would be entering the oil business? If this is government in the oil business, then we are likewise in the oil business when we build roads over which tank trucks transport petroleum products."

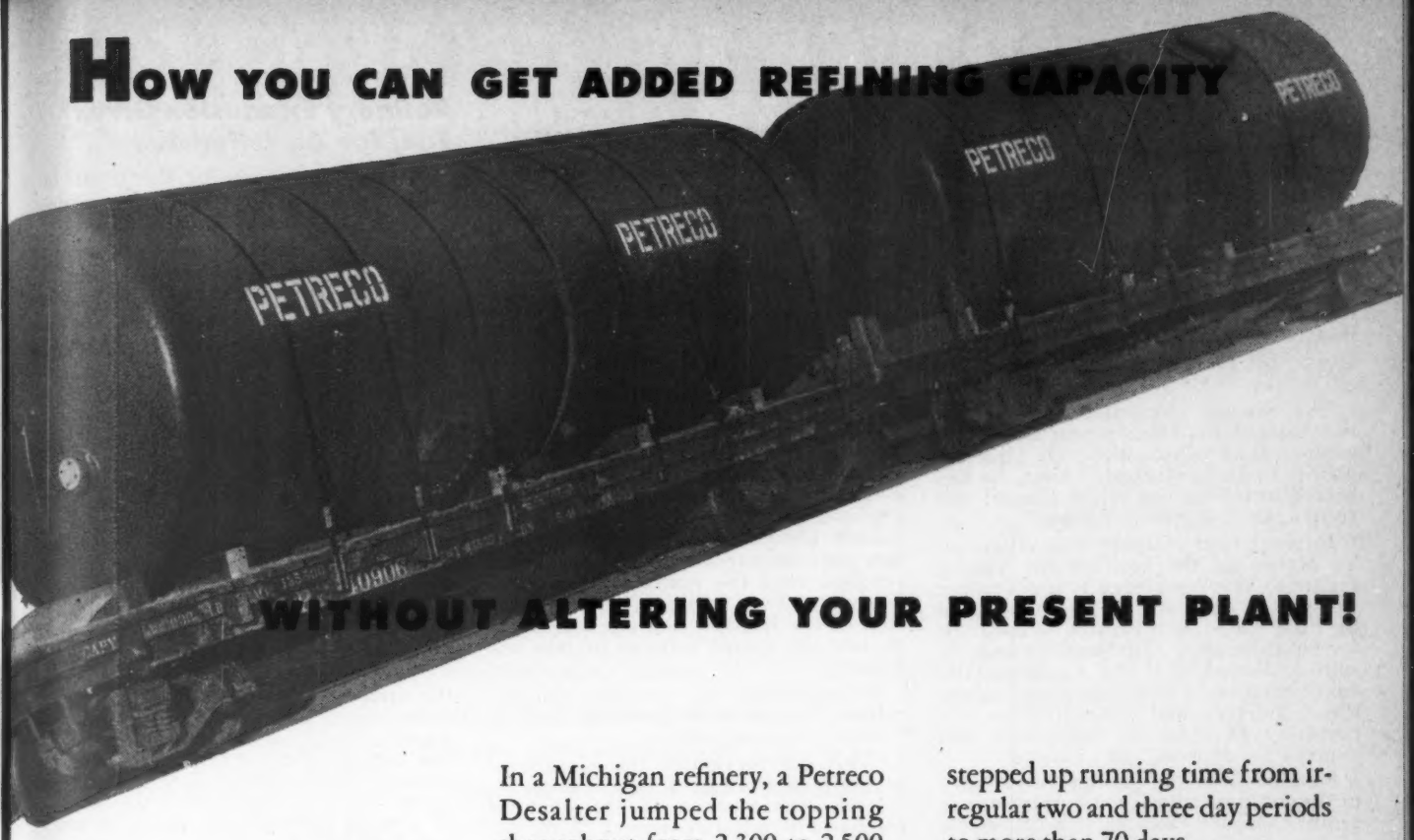
PRC also was the subject of discussion at the Capitol, where Secretary of the Navy Frank Knox told the House Foreign Affairs Committee March 9 the pipe line is a military necessity and essential to prevent the draining of vast amounts of oil from our own dwindling reserves.

The pipe line was brought up by Chairman Sol Bloom of New York during Knox's appearance in behalf of extension of the lend-lease act, and the Secretary explained that it is part of an effort by the government to provide for the acquisition of outside sources "for the safety and security" of this country.

"We're going to look into oil reserves all over the world," Knox declared. "We are building a pipe line into China now. This is the same thing. It is a military necessity."

At the other side of the capitol on March 10, Senator E. H. Moore of Oklahoma, co-author of the resolution for investigation of PRC and the oil situation, issued a lengthy statement originally prepared as a speech from the floor of the Senate, in which he charged the pipe line with being part of a "vicious and premeditated plan of the

How you can get added refining capacity



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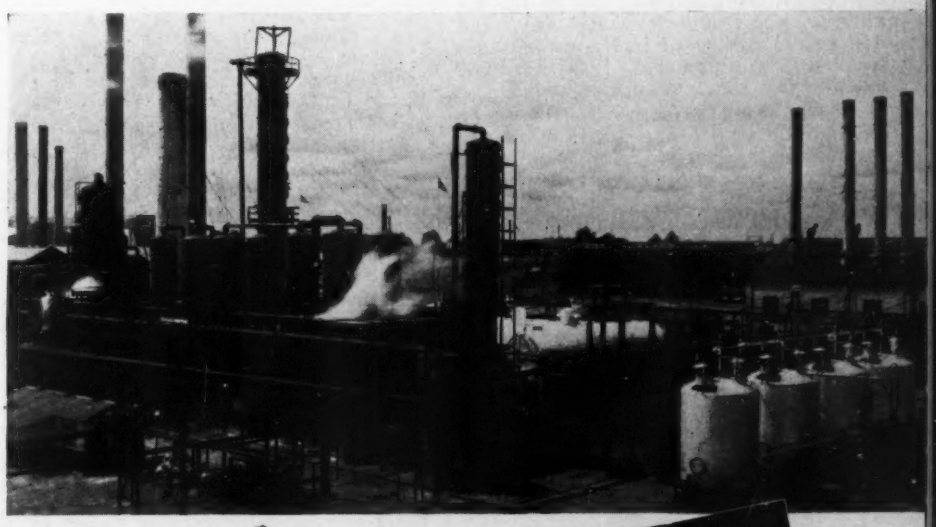
In a Michigan refinery, a Petreco Desalter jumped the topping throughput from 2,300 to 2,500 barrels, at the same time stretching 10 day runs to over two months.

A Kansas refiner added 500 barrels per day to its throughput and stepped up running time from irregular two and three day periods to more than 70 days.

A refinery in Illinois increased the daily charge from 3,500 to 4,000 barrels. Shut-downs due to salt troubles were completely eliminated.



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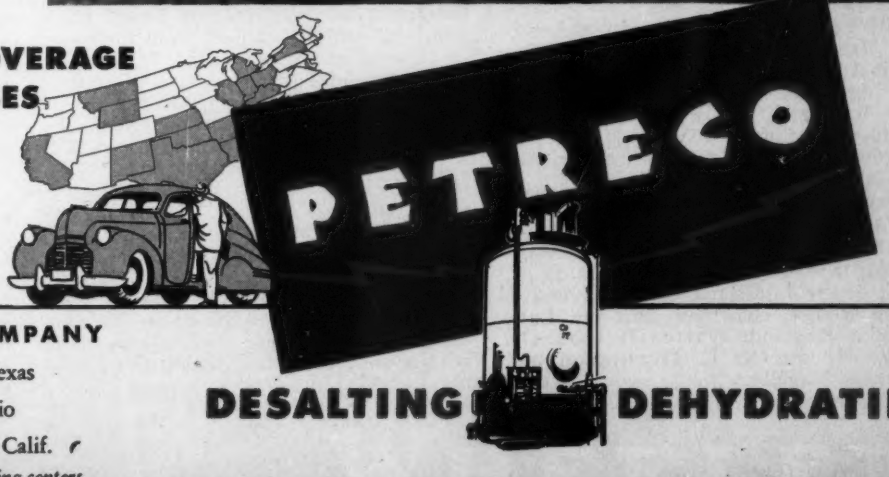

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administration to socialize the American oil industry."

"The procedure that has been adopted is so obviously dishonest that it warrants condemnation by the Congress and by the people of the United States," Moore asserted, declaring that the pipeline project followed a stream of propaganda from PAW and other agencies to the effect that the oil resources of this country have been exhausted and our people are faced with an immediate oil famine.

The Senator charged that there are two reasons for Ickes recent announcement that he will continue his pipe line plan until he is stopped: "First, he has been directed by the White House; and second, he is a willing puppet."

Impeachment of Ickes was suggested by Moore on the basis of his alleged failure to keep his pledge to the Truman Committee that any program adopted by PRC would be presented to congress for consideration. "In complete and insulting disregard of the Congress, the administration is plunging ahead before the Congress shall have had an opportunity to consider the matter and express its opinion," he charged.

Summarizing the production history of the oil industry over the past quarter century, Moore declared that "a review of our petroleum situation can lead to no other conclusion but that the Petroleum Reserves Corporation is an unwarranted scheme of the administration to socialize the oil industry and continue its program of fascist corporations in competition with every phase of private enterprise.

"The organization of PRC," he said, "sprang from the White House as a factor in the scheme to create a postwar transportation monopoly in the air and by water and it would strip the domestic industry of badly-needed material and equipment and further emphasize the shortage propaganda."

Moore urged that the Senate Audit Committee take prompt action on the resolution for investigation, "in order that the Congress may proceed with its investigation of PRC before additional secret international commitments are made without the consent and advice of the Senate.

"The American oil companies involved," he concluded, "should also understand that they are proceeding in this matter at their own peril, without any assurance that the project will be approved by the Congress."

AIMME Regional Meet Set for Houston in May

The Petroleum Division of the American Institute of Mining and Metallurgical Engineers will hold its spring meeting at the Rice Hotel, Houston, May 8, 9 and 10. In addition to the meeting of the Petroleum Division, a regional meeting of the institute will be held at the same time.

A tentative program has been prepared but it is not too late to add additional papers. The program committee for the division consists of B. C. Craft of the Louisiana State University, Baton Rouge, chairman, and Jan Law, Douglas Ragland, Warren Jackson, Dr. C. R. Hocott, R. L. Huntington and Herman Kaveler.

The Petroleum Industry War Council is having copies printed of George A. Hill's "White Paper." Copies may be had by writing the Council at 1625 K Street, N. W., Washington 6, D. C.

Gas Institute Adopts Research for Duration

Activities of the Institute of Gas Technology, Chicago, have been restricted to research for the war period. This decision followed the ruling that graduate students in engineering and science are no longer eligible for military deferments. Twenty students were enrolled when the winter term ended in February. Two will join the research staff of the institute and the others will go into the armed services or into war industry.

In explaining the decision and the future program of the institute, John I. Yellott, director, said:

"This interruption of the educational program of the Gas Institute is an inevitable consequence of the changed emphasis of selective service. Although we regret that the educational program has had to be discontinued for the duration, we plan to re-establish it on an expanded basis when conditions permit.

"We believe that, in the immediate postwar period, there will be great interest in the fellowships of the institute and plans will be laid out to put the educational program back into high gear just as soon as the departing fellows are available."

The Gas Institute, established in June, 1941, opened its educational program three months later—in September. The educational work was but one of four purposes for which the Institute was established.

Others include: (1) the prosecution of fundamental research is gas technology; (2) the collection and dissemination of scientific information; and (3) the conduct of applied research investigations on specific industrial problems.

"This halting of the student training program merely interrupts one phase of the service which the Gas Institute is rendering for the industry as a whole," says Prof. Yellott. "The resources of the Institute will now be turned more vigorously to basic research.

"Fundamental studies are about to be undertaken in both natural and manufactured gas," says Prof. Yellott. "Methods of synthesizing liquid fuels from gas will be studied, from the point of view of adding a valuable by-product to the gas industry, and also of replacing oil for the upgrading of gas. Basic studies will also be undertaken on the nature of the fluidizing process, which appears to offer so much towards the future development of the gas industry.

"Facilities at the Gas Institute will continue to be improved and expanded," adds Prof. Yellott. "It is expected that new equipment for combustion laboratory and fluid metering laboratory work will be provided. Additions to the permanent Gas Institute staff will be made with a view to strengthening the teaching force."

Refinery Expansion Gives Fuel for Air Offensive

Nearly two thirds of the great increase in output of 100-octane aviation gasoline achieved in the two years following Pearl Harbor was obtained from refineries operating at the outbreak of the war, which in 1942 and 1943 more than doubled their production, it was disclosed by Administrator Ickes March 11.

"Our situation," Ickes explained, "was so desperate we couldn't wait for new plants to be built. So, in spite of the fact that 41 major units were completed by last December 31, only 35 percent of our increased production since Pearl Harbor and 20 percent of the total output of 100-octane in 1942 and 1943 came from the new plants. For the rest we must credit the ingenuity of the petroleum industry. Without it our tremendous air offensive would never have been possible.

"Few people realize the complexity of the equipment required for the intricate processes of molecule splitting and regrouping involved in making the superfuel our Air Forces need. The average 100-octane plant takes as long to construct as one of the Navy's Essex type of aircraft carriers, it required more man hours than to build two destroyers, and more carbon steel, bar, plate and structural steel than a cruiser."

Of the 64.5 percent contributed by existing refineries to increased production, PAW estimated that 22.8 percent was secured through use of cumene as a blending agent, 14 percent through mechanical improvements, 13.8 percent through conversion of catalytic-cracking units, 9.1 percent through the use of codimer as a blending agent, 3.5 percent from the addition of 0.6 cubic centimeter of tetraethyl lead, and 1.3 percent through the use of toluene and other blending agents.

The number of "cat" crackers converted to aviation fuel was not given.

Early in 1942 it was found that conversion of existing equipment would permit the production of a substantial volume of codimer which, through hydrogenation, could be converted into hydro-codimer. The first unit was converted in February, 1942, and by the third quarter of last year 65 plants had converted their codimer facilities.

Also early in 1942 it was found that cumene, made from benzol and petroleum gases, had a highly beneficial effect in improving certain operational characteristics of 100-octane and that substantial quantities could be obtained quickly by a slight modification of existing equipment. The necessary benzol was available even after all other critical requirements had been satisfied, and by the middle of 1942 cumene production was under way. Nearly 23 percent of the increase in 100-octane output during the two years was made possible by this step alone.

Another agent which may prove increasingly important was found in toluol, of which there was some available after the requirements of Army Ordnance had been met. To these supplies were added certain other secret blending agents, at least one of which, it was said, has far-reaching potentialities for improving still further the engine performance of our planes, should the need arise.

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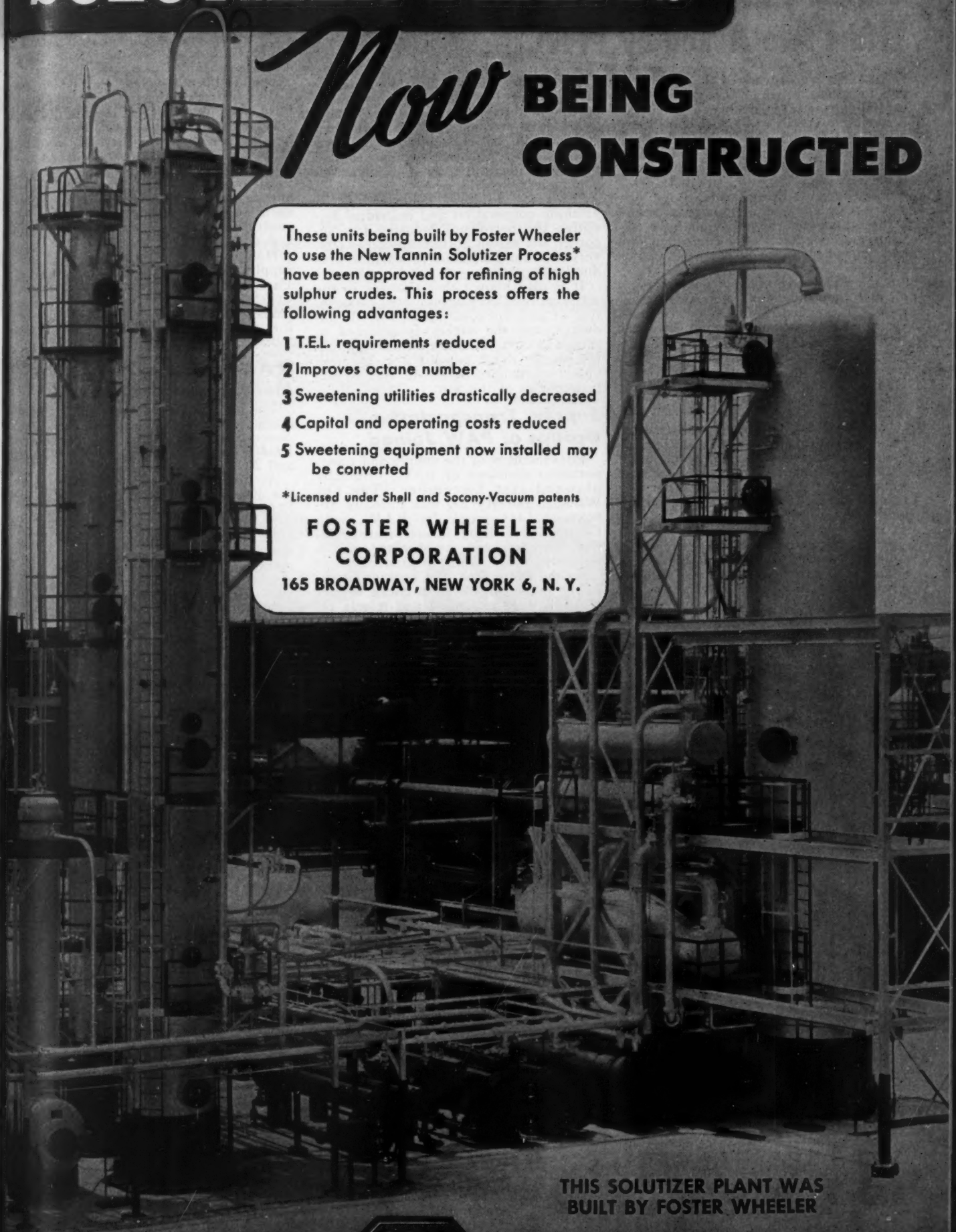

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Company Expenditures in War Effort Are Asked by PIWC

An extensive canvass of the oil industry to ascertain the total amount of capital expenditures, exclusive of federal financing, made by individual companies directly in furtherance of the war effort has been undertaken by the Petroleum Industry War Council, it was announced by Chairman William R. Boyd, Jr.

The study is being made, Boyd explained, to explode a popular misconception that government funds have entirely underwritten the new construction and expansion of the industry's wartime facilities.

A similar study made a year ago indicated that individual companies proposed to expend $673,000,000 in programs which, under normal circumstances, would not have been undertaken, to include $512,864,000 for war-created refining facilities, $136,661,000 for transportation facilities, and $23,484,000 for accelerated distribution facilities.

"Mis-statements from persons not properly informed frequently relate that the government is financing the construction of new facilities and even the expansion of existing facilities for the manufacture of petroleum war products," Boyd said.

"Facts prove otherwise."

Since the last census by PIWC, he added, a number of new projects and additions to existing plants and facilities have been undertaken, further to increase the output of products for war.

"It has been found also in a number of instances that the final construction cost on new 100-octane plants and plants to produce raw materials for synthetic rubber will be considerably different than as first estimated, requiring added private expenditure by individual oil companies," he said.

"This is additional evidence of the patriotic cooperation and individual initiative the petroleum industry has accorded the nation in its remarkable conversion from peacetime to wartime production."

It is also known that changes in the war program have necessitated cancellation of projects contemplated by the industry, and the survey is designed to secure as complete information as possible on the exact expenditures by individual companies solely to further the prosecution of the war.

Supply, Transportation Groups of PAW Joined

Consolidation of the supply and transportation divisions of PAW, originally planned last December (THE OIL WEEKLY, January 3), was formally announced last week by PAW, with George A. Wilson, former transportation division head, as director of the new supply and transportation division.

At the same time, the responsibilities of the marketing division under Walter Hochuli were expanded and it was retitled the distribution and marketing division.

To aid in the supervision of the supply and transportation division, Dane B. Hodges of Shell Oil Company, New York, was named associate director.

Under the new set-up, for which the district offices and advisory committees have been reorganized, the supply and transportation division will be responsible for the movement of all available stocks of crude and products from supply areas to refiners and from refineries to distribution areas. The distribution and marketing division will pick them up at supply terminals and exercise full control from those points to distributors and consumers.

Hodges has had wide experience in supply and transportation operations in East Coast, Mid-Continent and Pacific Coast areas. Since 1940 he has been manager of transportation and supplies for the combined Mid-Continent and Atlantic Coast areas.

IPAA Directors Will Meet in Pennsylvania

The mid-year meeting of the board of directors of the Independent Petroleum Association of America will be held in Bradford, Pennsylvania, April 27, 28, and 29.

At the same time, a joint meeting of the directors of IPAA and the National Stripper Well Association will be held.

Special emphasis will be placed on field practices in secondary recovery at the Bradford meeting. A tour of engineering and core-analysis laboratories in the Pennsylvania area to see tests made on sand to determine its susceptibility to water flooding also is planned.

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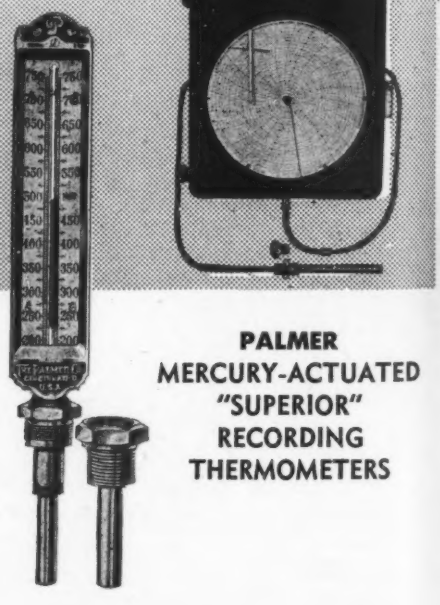

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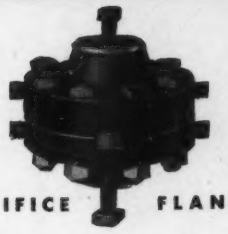
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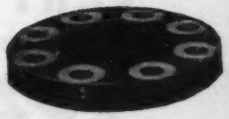
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Bureau Reports West Texas Crude Analyses

Analyses of crude oils from 43 West Texas fields have been compiled by the Bureau of Mines. The analyses were made under the supervision of R. A. Cattell, chief of the Bureau's Petroleum and Natural Gas Division; N. A. C. Smith, supervising engineer at the Bureau's Petroleum Experiment Station, Bartlesville, Oklahoma; and Harold M. Smith, senior petroleum chemist at Bartlesville. The tabulation was prepared by Boyd Guthrie, petroleum chemist at Bartlesville.

A copy of the publication, Report of Investigations 3744, "Analyses of Crude Oils from Some West Texas Fields," by Boyd Guthrie, may be obtained by writing the Bureau of Mines, Department of the Interior, Washington 25, D. C.

Federal Gasoline Tax For January Drops Off

Federal gasoline tax collections in January hit the lowest level in 12 months, dropping from $17,068,957 from $24,575,025 in December, it was announced by the Internal Revenue Bureau. The figure was $7,800,000 under the $24,884,420 for the first month of 1943, and brought the total for the first 7 months of the current fiscal year to $162,692,599, or $31,298,000 under the $193,990,616 received in the corresponding period a year ago.

Revenues from lubricating oil and pipe-line transportation also were at a low level, January collections of the former dropping to $3,370,483 from $3,697,398 in December and $4,156,532 in January, 1943, and the latter to $1,094,154 from $1,561,819 in December and $1,242,178 a year ago.

For the 7-month period, lubricating-oil collections aggregated $28,928,450, an increase of $5,100,000 over the $23,821,951 recorded last year, and pipeline transportation paid $8,903,116, an increase of $444,000 over last year's $8,459,048.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, Thirty-third, Federal and Dearborn Streets, Chicago, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only in one gram quantities, please inform the registry.

Barium platinic chloride (1 lb.)
Benzyloxy carbonyl chloride (carbobenzoxy chloride)
mono tert Butyl phosphite
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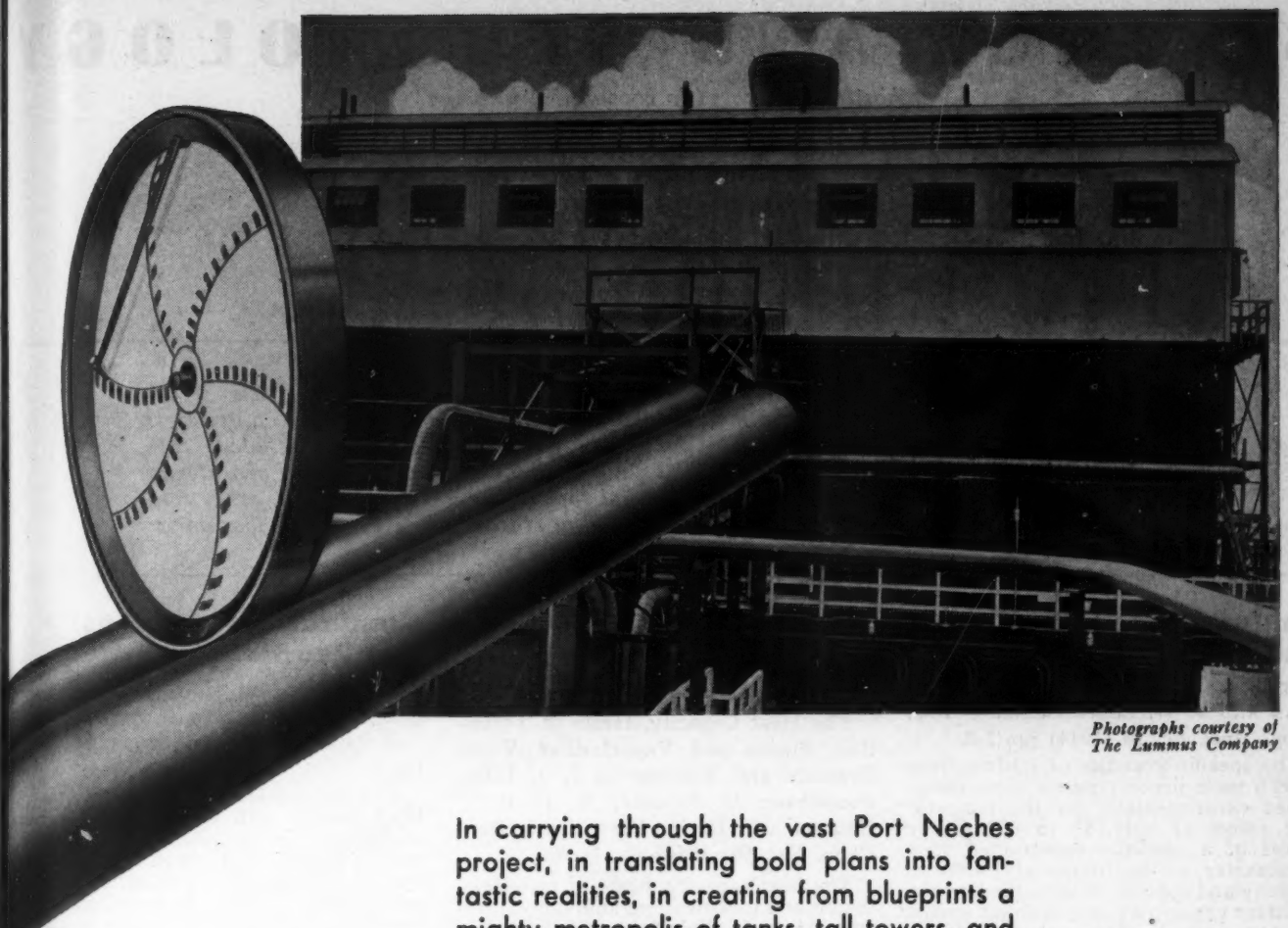
beta Diethylaminoethyl chloride or bromide
Eriochromcyanine R (10 g.)
Hexaphenyl ethane
p-Nitrobenzenediazo-p-aminoazobenzene (Cadion)
Penta brom ethane
Stilbene
Tri alpha naphthylamine
Tetra brom ethylene
Trimethyl urea



Photographs courtesy of The Lummus Company

In carrying through the vast Port Neches project, in translating bold plans into fantastic realities, in creating from blueprints a mighty metropolis of tanks, tall towers, and piping, *teamwork* between many men was responsible for the achievement. Credit belongs to chemist and engineer, to government official and oil company official, and to all who manufactured, delivered and installed the equipment. It is a source of real satisfaction that we at The Babcock & Wilcox Tube Co. had a part.

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DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical And Chemical Data

Specific Gravity of Butadiene. M. R. Dean and T. W. Legatski. *Ind. & Eng. Chem., Anal. Ed.* **16** (1944) pp. 7-8.

The specific gravities of 1,3-butadiene of 99.6 mole percent purity were determined experimentally for the temperature range of —17.78° to 60° C. by means of a specially constructed steel pycnometer of approximately 4500-cc. capacity and capable of withstanding the resultant vapor pressures without undergoing a permanent change in volume. The experimentally determined specific gravities were smoothed graphically and the experimental and smoothed values were compared to show the magnitude of the probable error in the smoothed data. The densities reported were compared with densities found in the literature, and it was concluded that the final interpolated values determined in the work were probably correct to ± 0.00015. The best value for the specific gravity (60°/60° F.) of pure 1,3-butadiene was estimated to be 0.6274 ± 0.00015. The method and apparatus used in the work are described in some detail and the experimental results are summarized in tables.

Phase Equilibria in Hydrocarbon Systems. H. H. Reamer, R. H. Olds, B. H. Sage, and W. N. Lacy, *Ind. & Eng. Chem.* **36** (1944) pp. 88-90.

In recent years a rather extensive background of experimental data has accumulated relating to mixtures of the lighter paraffin hydrocarbons. These have served as a source material for the basis of several methods of predicting the volumetric and phase behavior of hydrocarbon mixtures. However, no study has been made to determine the influence of carbon dioxide upon such systems. Therefore the volumetric behavior of four mixtures of methane and carbon dioxide was studied in detail at pressures up to 10,000 pounds per square inch, in the temperature range 100° to 460° F. The materials used and the methods employed in the work are described briefly. The results are presented in detail in tabular and graphical form. The volumetric behavior of pure carbon dioxide was also determined as part of the experimental program. It is concluded that predictions of the influence of small concentrations of carbon dioxide in gaseous hydrocarbon mixtures can be made without great difficulty.

The Heat Capacity, Heats of Transition, Fusion and Vaporization, Vapor Pressure and Entropy of 1, 1, 1-Trifluorethane. H. Russell, Jr., D. R. V. Golding and D. M. Yost. *Jour. Amer, Chem. Soc.* **66** (1944) pp. 16-20.

The heat capacity, heats of transition, fusion and vaporization, and vapor pressure of 1,1,1-trifluorethane were measured in the temperature range 13-226° K. From these data the calorimetric entropy has been calculated. The Raman spectrum data have been reconsidered and slightly revised. From this and other molecular data, the entropy of the compound was calculated statistically. Comparison of the calculated and observed entropies indicates a barrier of 3450 ± 400 cal./mole hindering the internal rotation of the molecules.

The Viscosity Function. E. P. Irany. *Rheol. Bull.* **14** No. 3 (1943) pp. 23-6.

In previous work simple mathematical quantities such as log n or the fluidity (ϕ) have been employed. These cannot be used successfully over a wide range. The author assumed a diagram in which the viscosity function of the liquid is linear against the appropriate unit of temperature, volume or pressure. The measured viscosities give the data for the fixed points of a scale that can be completed by interpolation.

Spectroscopic Evidence for Conjugation in Cyclopropane Systems. I. M. Klotz. *Jour. Amer. Chem. Soc.* **66** (1944) pp. 88-91.

The absorption spectra of a number of compounds containing a cyclopropane ring adjacent to an olefinic or carbonyl group have been examined and have been interpreted in terms of resonance due to hyperconjugation. The ultraviolet absorption spectra were obtained with a Beckmann quartz spectrophotometer. The instrument used a hydrogen arc as a source of ultraviolet radiation and a photocel-amplifier combination as a detector. The spectral region covered was from 2230 to 4000A.

Chemical Compositions And Reactions

The Alkylation of o- and p-Xylene. Dorothy Nightengale and J. R. Janes. *Jour. Amer. Chem Soc.* **66** (1944) pp. 154-5.

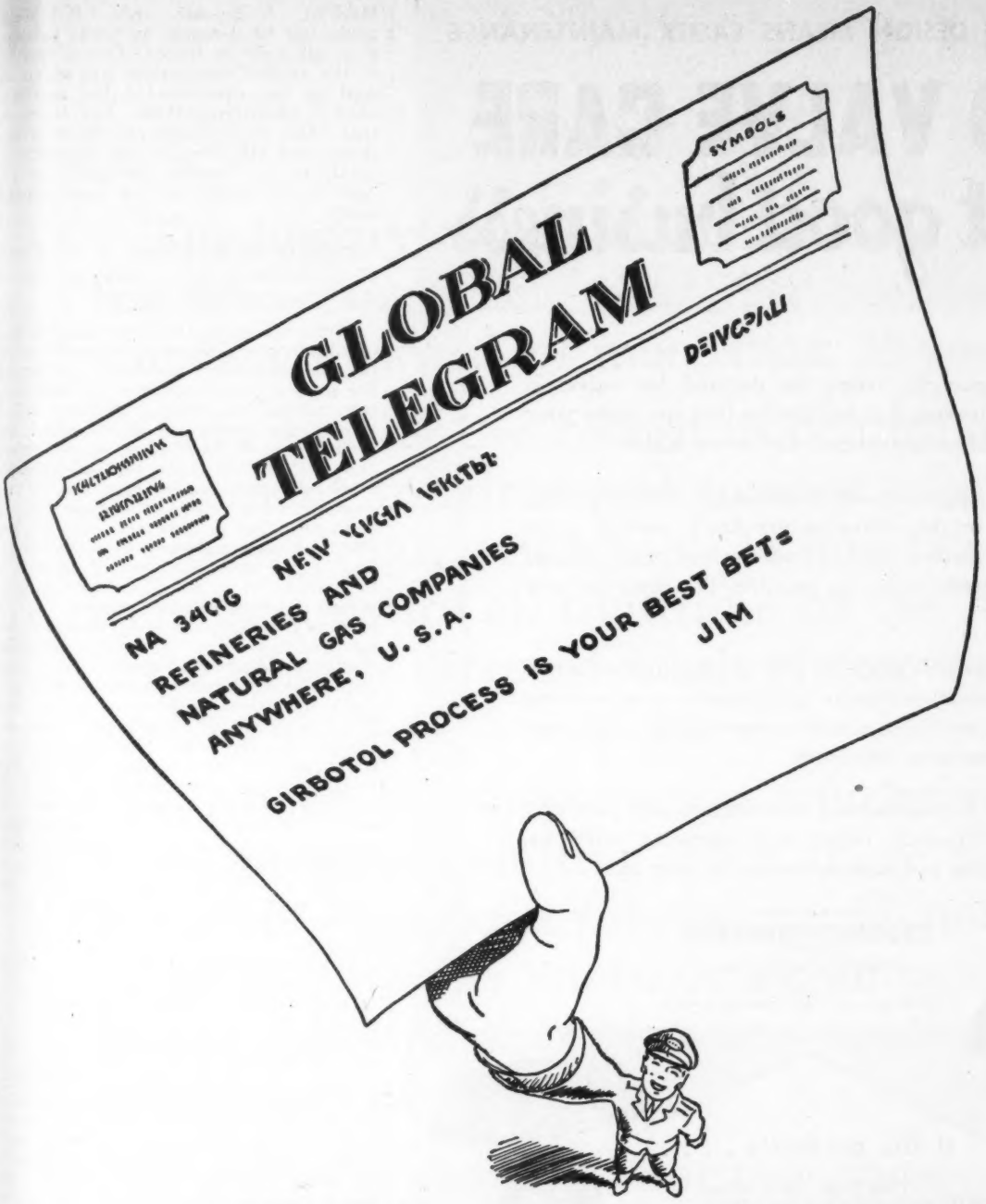
The authors found that o-xylene alkylated readily with t-butyl chloride and anhydrous ferric chloride and with t-butyl alcohol and boron trifluoride to form 1,2-dimethyl-4-t-butylbenzene in good yield. As might be expected, p-xylene did not alkylate as readily as the o- and m-xylenes. Toluene alkylated readily with isobutylene and ferric chloride. The experimental results are briefly described.

Structure of Copolymers of Isobutylene and Isoprene. J. Rehner, Jr. *Ind. & Eng. Chem.* **36** (1944) pp. 46-51.

Rubberlike materials prepared by low-temperature copolymerization of isobutylene with isoprene constitute part of a more general class of olefindiolefin copolymers now known arbitrarily as Butyl rubber. The structure of isobutylene-isoprene copolymers of various degrees of unsaturation was investigated by the method of ozone degradation. The conclusion was reached that the isoprene units in the copolymers are exclusively in the 1,4 position as in natural rubber, the proportion of any 1,2 or 3,4 addition units being much less than one percent of the diolefin present. It was also found that there is no tendency for the diolefin units to occur in sequences; the diolefin therefore enters the growing polymer chain at random during polymerization.

The Alkylation of Paraffin with Olefins. The Identification of the Paraffins Formed. A. V. Grosse and V. N. Ipatieff. *J. Org. Chem.* **8** (1943) pp. 438-47.

Hexanes obtained in the course of the reaction between trimethylmethane and ethylene using BF_3 or $AlCl_3$ as catalyst were studied. They were identified by converting them into the bromine or NO_2 derivatives or by the Raman spectrum. It was found that they consisted chiefly, that is, 90-70% $Me_2CHCHMe_2$, 10-25% Me_2CHPr and less than 3%



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Me_2CEt. N-Hexane and EtCHMeEt could not be detected and was present, if at all, only in traces. The properties of the several compounds are given, as well as the reactions to the methods used in identifying them. The reactions that take place between trimethylmethane and ethylene in the presence of catalysts are briefly discussed in the light of the result of the experimental work.

Stability of Butadiene. R. F. Robey, H. K. Wiese, and C. E. Morrell. *Ind. & Eng. Chem.* **36** (1944) pp. 3-7.

The purpose of the investigation was to obtain more detailed information on the chemical reactions occurring during the storage and handling of butadiene, thus permitting more intelligent selection of the conditions under which the diolefin can be handled or stored safely and with a minimum loss of valuable material. Butadiene is unstable in two possible ways: first, with respect to its elements; that is, reversion into carbon and hydrogen, and second, in the formation of polymers. Conjugated dienes can be considered as compounds existing at a high level of chemical energy with a tendency to drop to lower levels either by decomposition or polymerization. Under conditions affordnig poor dissipation of heat, these reactions can produce high localized temperatures and thus proceed spontaneously with extreme rapidity. The two reactions of most interest are: dimerization by a Diels-Alder type condensation, and (2) polymerization to plastic materials of high molecular weight. The first reaction is bimolecular and homogeneous in the liquid phase under a variety of conditions. Bimolecular reaction rate constants have been determined for a range of temperatures and compared with the constants for the gas phase reaction. The values of these constants are nearly the same. The formation of higher-molecular-weight polymers is peroxide-catalyzed. For a number of peroxide catalysts the rate of polymerization to plastic substances is proportional to the square root of the peroxide concentration. Data on the rate of peroxidation of butadiene are also included in the article. The addition of suitable antioxidant material inhibits the formation of high-molecular-weight polymer but has no appreciable effect on the rate of dimer formation. Although butadiene is readily peroxidized by air, this peroxidation can be inhibited for a time by antioxidants. The peroxides are not readily volatile and accumulate in the residue if the diene is evaporated or distilled. Concentration beyond a certain point yields an unstable residue that may decompose with violence when heated. Precautions for distillation of such peroxidized material are given.

C_2H_2 Polymer Produced in Electric Discharge. G. Glockler and C. A. Hollingsworth. *Trans. Electrochem. Soc.* **84** (1943) (preprint) 10 pp.

Acetylene and ethylene were polymerized in silent and semicorona discharge and the product obtained from these gases and their mixtures examined. Various properties of the acetylene polymer were studied, such as light transmission of thin films in the visible region, i.e. 4000 to 7000 A. It was found that oxygen absorption follows an exponential curve in the beginning stages of the reaction and after about 30 hours

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a more complex relationship expressed the oxidation. At this stage diffusion through the already oxidized portion of the solid particles of the polymer becomes an important factor. No solvent was found for the material but methyl alcohol can be used to give colloidal solution. It is not thermoplastic, as is shown by its behavior under pressure and temperature.

Manufacture: Processes And Plant

Petroleum as a Source of Synthetic Materials. Discussion opened by A. E. DUNSTAN, F. H. GARNER, AND J. A. ORIEL. *Jour. Inst. Petr.* **29** (1943) pp. 308-22.

The subject of petroleum, and the hydrocarbon fragments derived from it, was discussed in relation to utilization of the materials as chemical raw materials. Reactions of polymerization and alkylation were considered in relation to commercial developments. Isomerization was discussed, as well as the utilization of olefins in the manufacture of such compounds as glycerol. The relationship of synthetic rubber to petroleum was briefly considered. Petroleum as a raw material in the manufacture of plastics was discussed.

Fibrous Glass as a Packing Material for Packed Column Distillation. G. W. MINARD, J. H. KOFFOLT, AND J. R. WITHROW. *Trans. Amer. Inst. Chem. Engrs.* **39** (1943) pp. 813-51.

The authors summarize the results of some 600 test runs on the use of fibrous glass as a packing material for packed column distillation. The work was done using a 1-foot diameter column packed to a height of 6.5 feet, and another packed to a height of 1.5 feet. Data are reported for both the enriching and stripping sections on two industrially important binary systems, ethanol-water, methanol-water, and also enriching of acetone and water. The effects of reflux ratio, vapor velocity, and composition on the performance characteristics are summarized. The results of the investigation indicated that fibrous glass appeared to possess the properties of a satisfactory material for industrial packed column distillation work; namely (1) good rectifying performance; (2) high rate of throughput with low pressure drop; (3) low holdup; (4) light weight per unit volume; (5) consistent behavior; (6) with low cost.

The Lines in Quaternary Liquid Systems. J. C. SMITH. *Ind. & Eng. Chem.* **36** (1944) pp. 68-71.

Binary liquid mixtures can often be separated easily by extraction with a third liquid; consequently, liquid-liquid extraction has found an ever-increasing use in industry. Recently there has been a considerable increase in the use of mixed-solvent extraction, particularly in petroleum refining. In this operation the third liquid, or solvent, consists of two liquid components that are completely miscible with each other. Usually only one of them, however, is completely miscible with the solution treated; the other is only partially miscible with the stock mixture. Thus mixed-solvent extraction leads to the handling of four-component liquid systems and to rather

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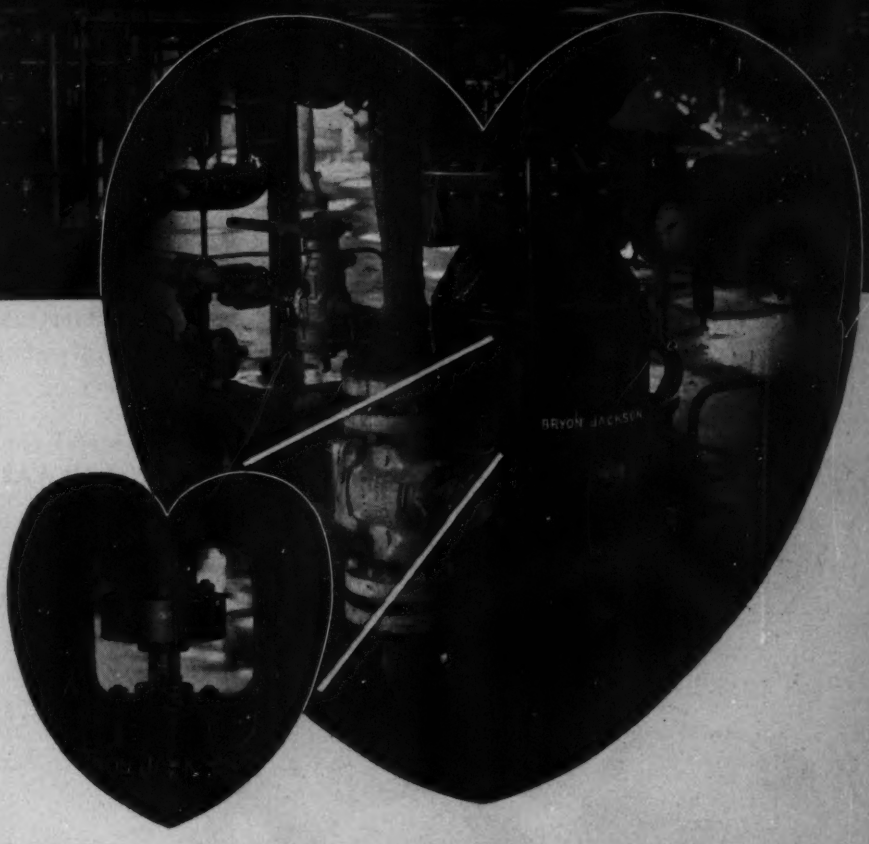

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complicated stoichiometric calculations. A method of representing equilibria in quaternary liquid systems by means of plane graphs is described. Graphs permit accurate interpolation and the rapid solution of problems in mixed solvent extraction. Construction of the charts is presented in some detail. A problem example is given and the method of its solution outlined. The solution is obtained in a matter of minutes, while several hours of graphical calculations are necessary when previous methods are used.

The Adsorption of Gases and Vapors. Volume I. Physical Adsorption. S. BRUNAUER. *Princeton University Press,* Princeton, N. J., 1943. vii + 511 pp. Price, $7.50.

The book is an interesting and worthwhile contribution to the literature of adsorption. Although dealing with a mass of heterogeneous and sometimes contradictory material, the author has succeeded in achieving an orderly and logical presentation. A general description of the main phenomena and methods of investigating them is followed by more detailed developments of particular topics such as the shape of the adsorption isotherms, the surface of the adsorbent, and the kinetics of the process.

Closures for High-Pressure Vessels. D. MEIGS. *Trans. Amer. Inst. Chem. Engrs.* **39** (1943) pp. 769-91.

Although many types of construction have been devised and published for closing high pressure vessels, in general each closure is useful for a given class of service, and is most applicable to a certain pressure range and a certain range of sizes, beyond which another design is preferable. The designer must consider several factors, most important of these being pressure, frequency of opening the closure, diameter of the opening to be closed, and what must pass through the opening. Grouping the various forms of closures under the headings of permanent closures, flanged closures, screwed closures, and Bridgman closures, these factors are discussed. About a score of different types of construction are described and illustrated, and cost data are presented where available, applicable chiefly to openings two feet or less in diameter, and for pressures in the range 1000 to 100,000 pounds per square inch.

Economic Selection of Exchanger Sizes. H. TEN BROECK. *Ind. & Eng. Chem.* **36** (1944) pp. 64-7.

The purpose of the paper is to provide a method for the economic selection of the sizes of individual units in a battery of exchangers. The type of battery considered is one in which a stream, called the "series stream," flows through all the units in series and engages in heat transfer with various side streams. Included in the battery are the coolers required to cool each stream to the desired final temperature. Equations are developed for 1-2 and 2-4 type multipass exchangers and for countercurrent exchangers. The costs considered in making the analysis are those of the exchanger itself, maintenance, installation, heat, and water. Derivation of the equation is given in detail. An example is given to illustrate the use of the equation. The system examined represents a preheat battery for a crude oil

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topping unit. The first exchanger is a condenser for the overhead product and reflux, the second is an intermediate reflux heat exchanger and the third is a side-stream exchanger.

The Development of the Hydrogen Fluoride Alkylation Process. C. G. GERHOLD, J. O. IVERSON, H. J. NEBECK, R. J. NEWMAN. *Trans. Amer. Inst. Chem. Engrs.* **39** (1943) pp. 793-812.

The development of the hydrogen fluoride alkylation process under conditions of the war emergency has raised many problems of interest to the chemical engineer. These problems resulted from the unusual properties of hydrogen fluoride from the standpoint of its behavior toward materials of construction, as well as its properties from the physiological point of view, and from the complexities of the chemical reactions occurring under alkylating conditions. The authors review some of these problems, the methods used in developing solutions of them, and the solutions themselves. Of particular interest in connection with the process is the use of anhydrous hydrogen fluoride on a much larger scale than previously, as, for example, involving single units containing as high as 20,000 gallons of hydrogen fluoride and the circulation of streams as large as 300,000 gallons per minute containing hydrogen fluoride.

Products: Properties And Utilization

The Filter Freezing Temperature of Aviation Fuels. J. M. A. COURT. *Jour. Inst. Petr.* **29** (1943) pp. 329-31.

When a fuel flows under controlled conditions through a wire gauze filter of defined dimensions, the highest temperature at which the rate of flow falls below a specified critical value is defined as the filter freezing temperature. A method for the determination of this temperature has been submitted to and discussed by Standardization Sub-Committee No. 3 of the Petroleum Institute. Certain proposed blends of aviation fuel have a high water solubility, tend to precipitate ice at low temperature, with resultant freezing or blocking of the filter screens of aircraft fuel filters. The apparatus used in the method is described in some detail, as is the procedure to be followed in making the test. The method is presented in order to obtain suggestions and criticisms.

The Chemical Background for Engine Research. R. E. BURK AND O. GRUMMITT. Interscience Publishers, Inc., 215 Fourth Ave., New York, N. Y., 1943, vii + 297 pp. Price $3.50.

The book comprises a group of lectures on particular topics in the field by six leading authorities, and is the second successful course of this type given at Western Reserve University in an effort to present both the student and the mature chemist with an intelligible view of the current knowledge in the field. A chapter entitled "A Survey of Combustion Research" presents a brief historical review and description of modern methods of studying flame travel. "Chemical Thermodynamics of Hydrocarbons" gives the calculation and best values of the entropy, heat and free energy of formation, and isomeriza-

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tion equilibria. "Synthetic Methods for Hydrocarbons," contains a survey of the typical laboratory Grignard reactions used. "Kinetics of Flame and Combustion" is restricted to the slow oxidation and self-ignition of hydrogen and the paraffin hydrocarbons. Another chapter explains the devices used to measure flame travel, pressure, and temperature in the automobile engine, and reviews present knowledge of knocking combustion. The final chapter on lubrication is a comprehensive survey covering engine ring sticking and bearing corrosion, oil oxidation and detergency studies, and boundary lubrication theory and testing.

A Study of Oil Oxidation as Related to Lubrication. Part I.—Apparatus, Technique, and Preliminary Results. P. G. EXLINE, W. E. KRAMER, AND J. R. BOWMAN. *Jour. Inst. Petr.* **29** (1943) pp. 295-307.

The oxidation of a lubricating oil can alter its behavior in a journal bearing to extend the range of operation beyond that normally secured from the same oil before oxidation. Recent studies led to the conclusion that the effect noted is not due to any great extent to a change in the oil, but can be accounted for by changes in the form and surface finish of the bush bearing. The authors investigated this subject, believing that a positive effect of oxidation was to be anticipated and that the mechanical variables could be controlled if all parts are maintained at constant temperature. They also provided means for controlling the rate of oxidation of the oil, for a steady increase of load up to incipient seizure, and for permitting determination of the point of incipient seizure in a manner giving reproducible results. A special apparatus was built for the purpose, and is described in some detail in the article. A new bearing and journal assembly was used for each run. The journal surface was ground and lapped to a fine finish and the bearing was finally lapped to an inside diameter 0.001 inch greater than the journal. Measurements of surface irregularity were made with a profilometer and the data secured are tabulated. The oil used was vacuum distilled to remove the last traces of dissolved oxygen, and was transferred to the sump in an atmosphere of oxygen-free nitrogen. Great difficulty was had in obtaining a truly inert atmosphere. Commercial tank nitrogen was wholly unsatisfactory. The data from the operation of the machine comprised complete, continuously recorded load-time and torque-time charts. A highly refined paraffinic oil, the properties of which are given, was used in one series of runs. The most striking phenomenon exhibited is the large increased of load-carrying capacity of the oil during oxidation, value frequently becoming twice that of the unoxidized oil. Even more remarkable is the indication that the effect is temporary; displacement of the oxidizing air with an inert nitrogen causes the seizure load to decrease to near its value before oxidation, and in some instances to even less than that amount. The more extensively the oil is oxidized, is the longer the time for the return. Apparently the initial oxidation products of the oil that delay incipient seizure are strongly adsorbed on the bearing surfaces, but are unstable. The results with a naphthenic

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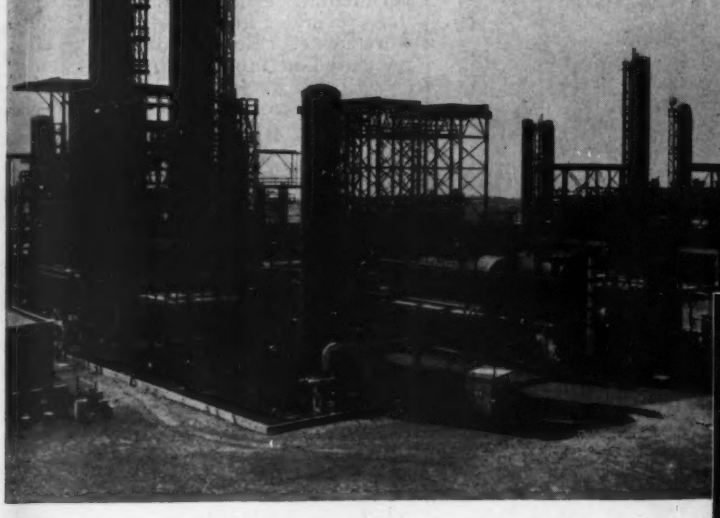

The plant pictured is the latest addition to Sun Oil Company's Marcus Hook Refinery. This plant can produce in one week sufficient 100-Octane gasoline to propel 2000 bombers from England to Berlin and back.

Brown Instrument Company Instruments in Main Control Room of Houdry Catalytic Cracking Unit. Sun Oil Company 100-Octane Aviation Gasoline Refinery, Marcus Hook, Pa.

to the oil industry the ideal synchronization of measurement and control for temperature processes. It is the only potentiometer type controller in which the air control flapper mechanism is continuously positioned in response to temperature changes. Hundreds of installations have proved its sensitivity . . . ruggedness . . . simplicity . . . precision and unequalled ease of adaptation to process requirements. The Brown Circular Chart Air-o-Line *Electronic* Potentiometer Controller is the result of years of research, design and field testing.

Brown Potentiometers on Podbielniak Laboratory Equipment at Laboratory of Sun Oil Company 100-Octane Aviation Plant, Marcus Hook, Pa.

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oil were similar to those with the paraffinic oil up to the point of initial precipitation of sludge, after which the effects were reversed. The seizure load decreased when air was admitted and rose when it was excluded. In the case of the paraffinic oils the precipitation of insoluble material was accompanied by a marked increase in seizure load. In one run a proprietary inhibitor was added to the naphthenic oil. The seizure load remained quite constant for almost 200 hours, irrespective of the atmosphere to which the oil was exposed. To permit orientation of the experimental results with current practice, several commercial S.A.E. 20 oils were tested. Results of the tests are presented in tabular form.

The Railroad Aspect of Lubricating Greases. C. B. BRYANT. *Inst. Spokesman* 7 No. 3 (1943) pp. 1, 5-7.

Greases for use in locomotive driving-journals operate ordinarily under static loads of 200-300 pounds per square inch at speeds of 300-400 revolutions per minute and temperature of about 400°F. on carbon steel journals in copper-tin-lead bearings. Loads such as these are increased during short periods because of conditions of track, impact in starting, etc. The average grease consumption is 40-70 locomotive miles per pound of grease. The grease must have a high melting point, good storage stability and should not lose oil at the working temperature. Rail-curve grease is used to reduce the abrasion on the sides of the rails on curves where the wheel flanges and the side of the rail are under contact pressure that can be as high as 600,000 pounds per square inch. The grease for this purpose is similar to cup grease of No. 2 or No. 3 consistency and contains approximately 10 percent graphite. It should have a low solidifying point, good storage stability even at high temperature, good adhesiveness and resistance to water. The new specifications of the American Association of Railroads for brake-cylinder lubricants are given and briefly discussed. The Southern Railway System specifications for pressure gun grease include an adhesiveness test. In this the area covered by the grease is measured after a sample placed on the striking face of a circular drop hammer is spread on a metal base plate by letting the hammer drop a specified distance.

Pycnometer for Volatile Liquids. M. R. LIPKIN, J. A. DAVISON, W. T. HARVEY, AND S. S. KURTZ, JR. *Ind. & Eng. Chem., Anal. Ed.* 16 (1944) pp. 55-58.

Although many descriptions of pycnometers for special purposes have been published, a simple pycnometer for general use in hydrocarbon analysis, and particularly for obtaining precise densities on materials as volatile as pentane, has not been described. The authors describe a pycnometer that is well suited for the determination of density on 5 ml. of volatile liquid with an accuracy of ± 0.0001 gram per ml. Calibration of the pycnometer is discussed. Tests of the precision of the pycnometer were made using the method for the determination of precision densities. The results are tabulated. Each determination requires 10 to 15 minutes of the operator's time with an elapsed time of 20 to 30 minutes. With a damped balance,

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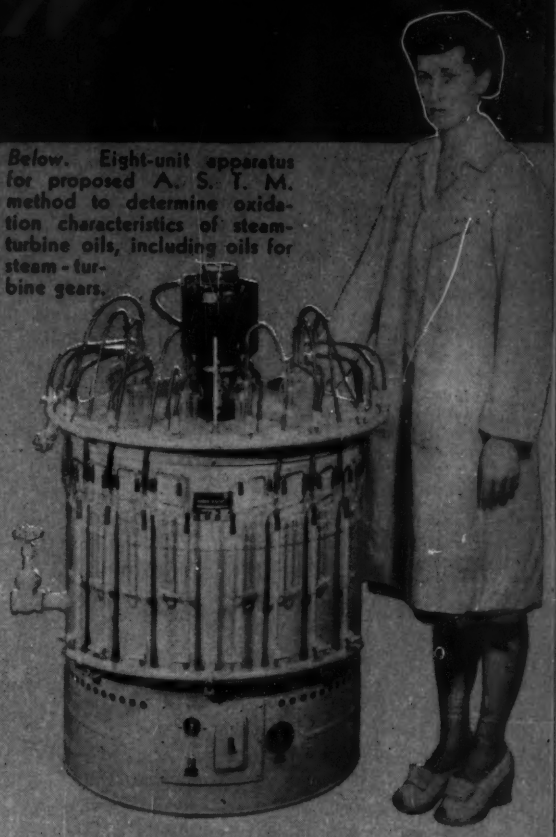
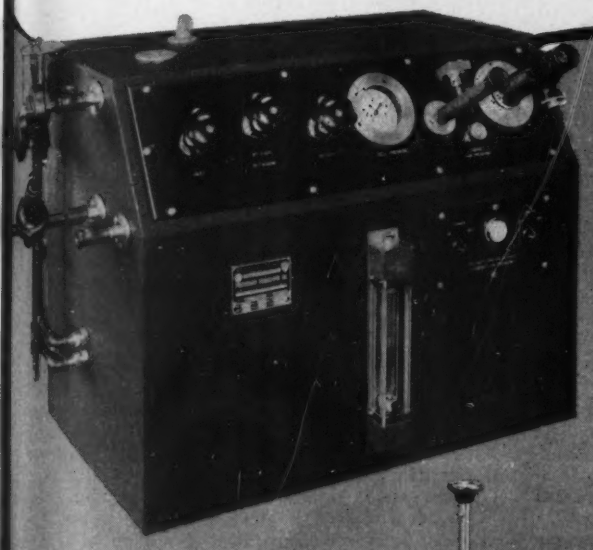
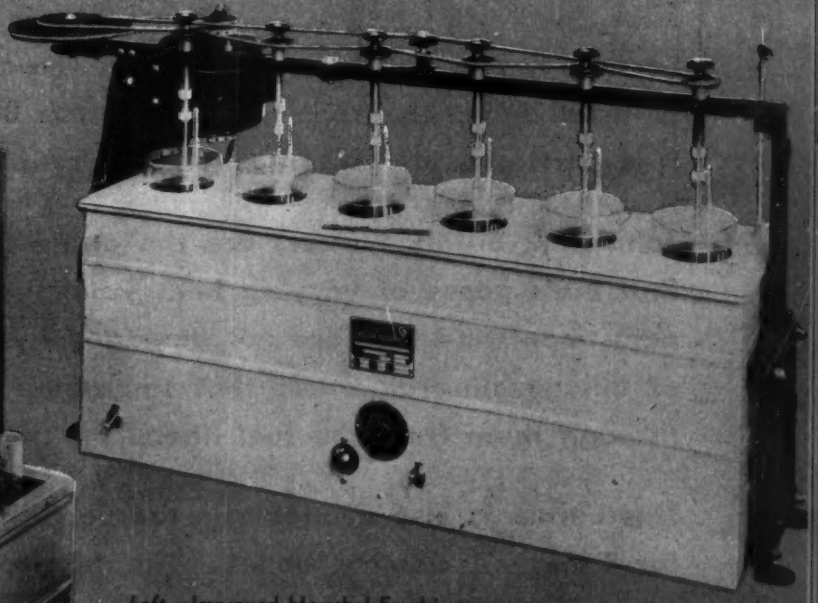


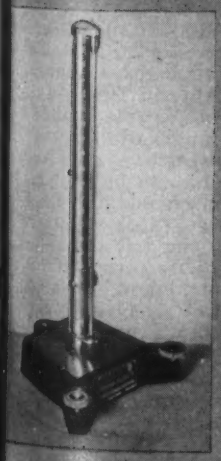
Below. Eight-unit apparatus for proposed A. S. T. M. method to determine oxidation characteristics of steam-turbine oils, including oils for steam-turbine gears.

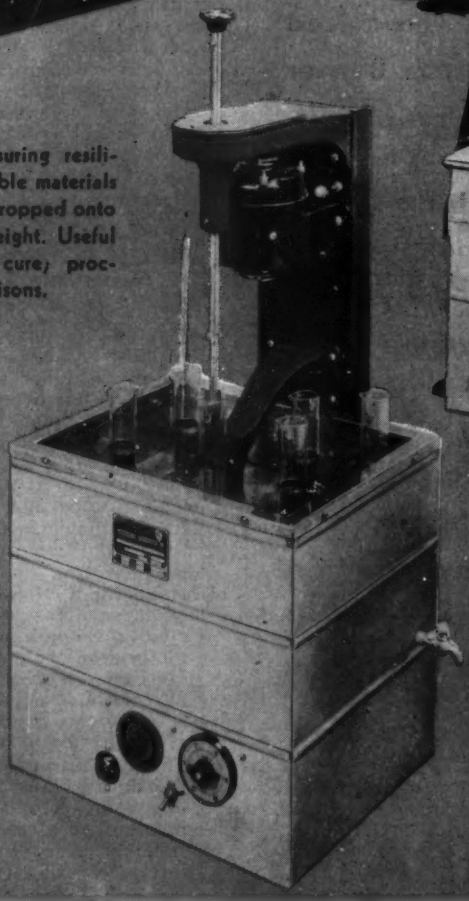


Left. Pressure refractometer designed by Shell Development Co., for measuring refractive index of butadiene flowing through pipe-line. No need to remove samples to laboratory. Wholly self-contained. Adaptable to liquids flowing under pressures from atmospheric to 100 lbs. and refractive index from 1.32539 to 1.54409. Fluid temperature and pressure are controllable.



Left. Improved Herschel Emulsifier for measuring rapidity with which oil separates from water, according to U. S. Gov't Master Specifications for Lubricants. Ball-bearing 1/20 H. P. Motor drives specified paddle at 1500 R. P. M. Constant temperature bath maintains 1/2° C. accuracy. Includes automatic time switch.





Above. Combination bath and multiple stirrer, for investigating rust-preventing characteristics of steam-turbine oil in presence of water, A. S. T. M. Tentative Method D665-42T. Polished steel speciment are immersed in oil, with water held in suspension by paddles rotating at 750 R. P. M. while temperature is maintained at 140° F. ± 2° F.

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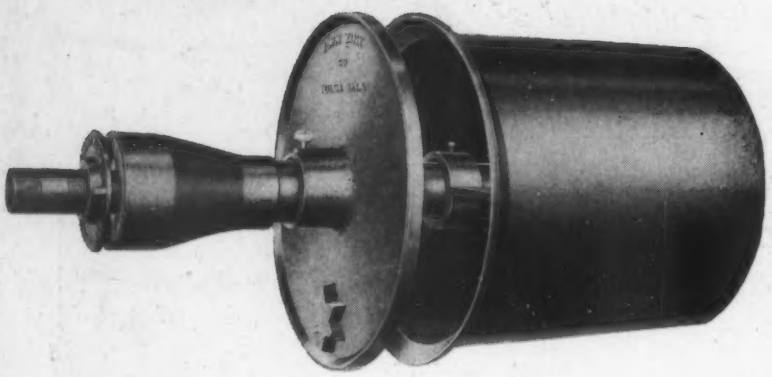

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Semiautomatic Pressure Control in Low-Pressure, Low-Temperature Laboratory Fractionation. D. R. DOUSLIN AND W. S. WALLS. *Ind. & Eng. Chem., Anal. Ed.* **16** (1944) pp. 40-42.

The paper describes a relatively inexpensive device for the semiautomatic control of pressure in low-pressure, low-temperature laboratory fractionating columns. The device is simple, and can be constructed of materials usually available. The device is described in some detail, including the throttling valve, liquid nitrogen dispenser, and nitrogen expander. The technique to be used in operation is given.

Determination of Tetraethyllead in Gasoline. H. GONICK AND J. J. MILANO. *Ind. & Eng. Chem., Anal. Ed.* **16** (1944) pp. 4-6.

A method for the determination of tetraethyllead in gasoline is described in which the tetraethyllead is decomposed with iodine and the lead subsequently titrated by a new acidimetric method employing 8-hydroxyquinoline. The method is rapid and is applicable to all types of gasoline. Methods previously in use are briefly reviewed. By the proposed method a single determination can be completed in one hour, and for determinations in quantity only a small fraction of this time is required per determination. More than three thousand samples of gasoline, representing all the principal brands and grades sold in the western states, have been analyzed successfully. The details of the apparatus and the method of procedure are described in detail. A tabulation is given showing a comparison of the results obtained by the A.S.T.M. method and the proposed method.

Estimation of Mercaptan Sulphur Alone or in Presense of Elementary Sulphur in Petroleum Products. E. R. H. DAVIES AND J. W. ARMSTRONG. *Jour. Inst. Petr.* **29** (1943) pp. 323-8.

A method for the estimation of mercaptan sulphur alone or in the presence of elementary sulphur in petroleum products has been submitted to and discussed by Standardization Sub-Committee No. 3 of the Institute of Petroleum. No originality is claimed for the method, but it is felt that publication would lead to possible constructive criticism from which a method could be evolved that would be more satisfactory than the present qualitative "Doctor" test. Available methods for the determination of mercaptans are briefly reviewed including the iodometric method, the lamp method before and after sweetening, the mercuric chloride method, cupric chloride method, cupric oleate method, the silver nitrate method, and potentiometric methods. The proposed method depends on the extreme insolubility of silver mercaptides and silver sulphide in alkaline solution and the relatively greater insolubility of silver sulphide compared to silver mercaptides, and further, on the interaction of elementary sulphur, mole for mole, with mercaptan sulphur producing silver sulphide through an intermediate sodium alkyl disulphide as shown by equations given. The endpoints of the titration are determined by measuring the change in potential of

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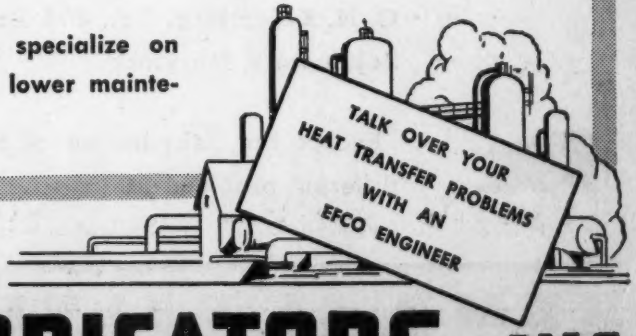

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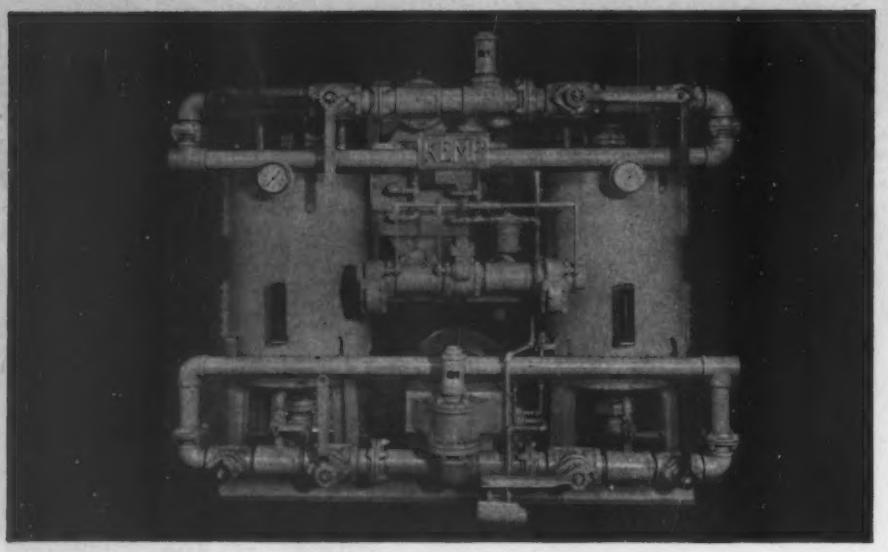

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a silver electrode immersed in the titration vessel and by a potentiometric procedure. The apparatus is described in some detail, as is the procedure to be followed. Results are given showing the precision of the method. In general the method is applicable to the determination of mercaptan sulphur and elementary sulphur in colorless or colored petroleum products. It is not affected by olefins, aldehydes, peroxides, inert sulphur compounds, dyes, phenols, naphthenic acids, fatty acids, nitrogen bases, or chloride ion. Hydrogen sulphide must be removed before making the determination.

Analysis of Petroleum Oil-Soluble Sodium Sulfonates by Adsorption. J. M. KOCH. *Ind. & Eng. Chem., Anal. Ed.* 16 (1944) pp. 25-28.

In the manufacture of medicinal white oil by treatment of the petroleum stocks with fuming sulfuric acid, sulfonic acids are formed, some of which remain dissolved in the oil layer after its separation from the sulfuric acid sludge. Upon neutralization of the "acid oil" layer with alkali, oil-soluble sodium sulfonates are produced. These "mahogany soaps" are extracted with aqueous alcohol and are further refined to produce commercially important emulsifiers. Products of this type are marketed largely as a blend consisting of approximately equal amounts of oil and soap, contaminated with small amounts of inorganic matter. To control the ratio of oil to soap in the mixtures, it is necessary to estimate at least one of the components. This can be done by separating the sulfonates from the hydrocarbons by means of some physical process. To avoid the large number of extractions and manipulations ordinarily required by the conventional method, the method described in the paper was developed. This is based on adsorption. The method compares favorably with aqueous alcoholic extraction analyses both in accuracy and precision. It is rapid and convenient and entirely free from emulsion difficulties. The apparatus and procedure are described in detail. Tabulated comparisons of analysis by the proposed method and by previously used methods are given.

Rapid Method for Determining the Oil Ratio in Water-Soluble Cutting Oils. R. H. WILLIAMS. *Chemist Analyst* 32 (1943) pp. 78-9.

A rapid method for determining the oil ratio in water-soluble cutting oils involves transfer of 20 cc. of the oil to a standard Babcock test bottle. 10 cc. of concentrated sulfuric acid are added and the whole gently shaken until the emulsion breaks. After centrifuging for 3 minutes and adding hot water the liquid column will approach the top graduation of the scale. The bottle should be centrifuged for 3 minutes and kept at 140° C. for 3 minutes. The oil is then measured from its lower surface to the highest point of the upper meniscus.

Thirty Million Dollars Set Aside for Rubber Plants

Approximately $30,000,000 will be spent this year in improving facilities for the production of synthetic rubber and its raw materials, it was announced February 17 by Rubber Director Bradley Dewey, and the highest priorities already have been granted to all of the scheduled construction and installation.

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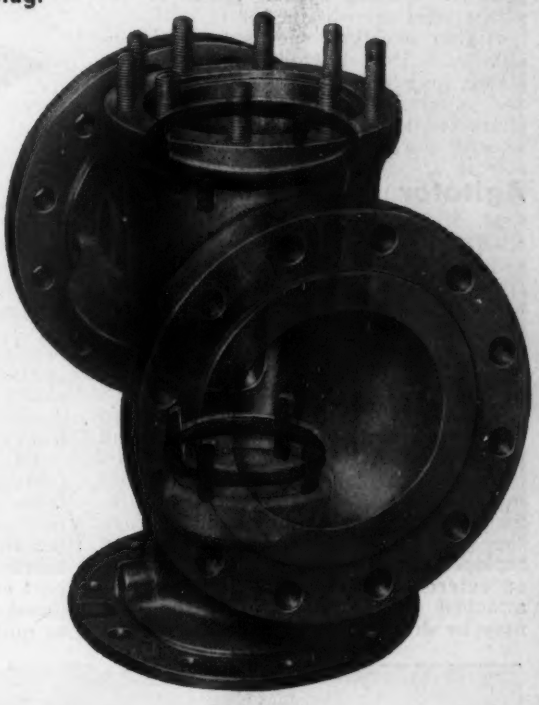

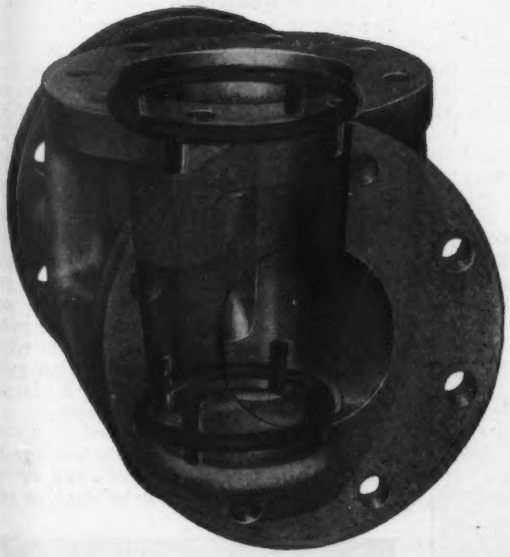

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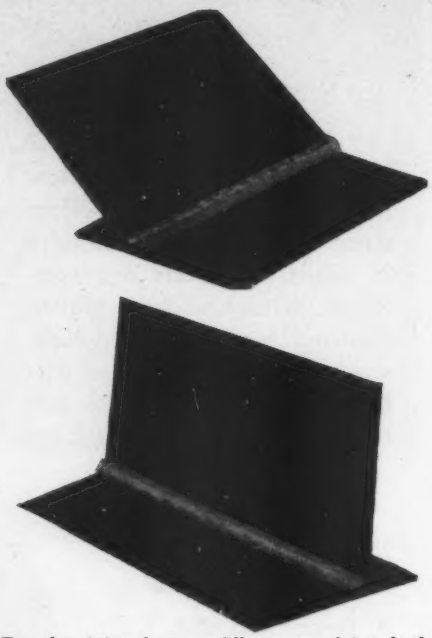
Higher welding speeds are obtainable with the electrode since it withstands higher currents, both alternating and direct. Also, its easy handling characteristics make it adaptable for general purpose work.



Top, lap joint; bottom, fillet or tee joint, both welded with "Fleetweld 37."

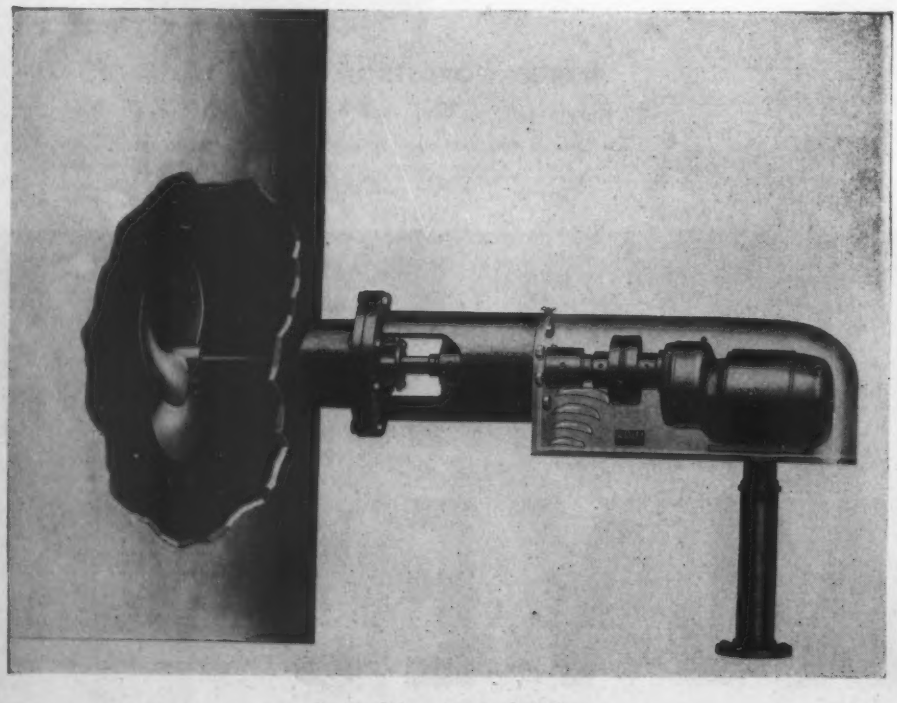
Agitator

H. K. Porter Company, Pittsburgh, 1, Pennsylvania, announces a side-entering agitator, which can be repacked from the outside without draining the tank and without loss of liquid. The company is in process of replacing its entire standard line of agitators, from ½ to 30 horsepower, with the new design.

The outside repacking can be done in 5 minutes, saving many man hours, and the expense of draining the tank, air-blowing it in cases where toxic fumes make this necessary to permit a workman to enter, and then pumping back the fluid after the packing has been replaced. This is accomplished by using an external packing gland, while a seal attached to the shaft inside the tank may be drawn into a seat, hermetically sealing off the contents of the tank and permitting repacking with the tank full and no loss of liquid.

All thrust is taken off the motor bearings by means of roller bearings operating against a ring attached to the shaft, and by means of undercuts, the designers have made it impossible for leakage to get at the bearings.

The new unit is completely weatherproofed with all moving parts protected from the elements, and can be installed outdoors. Motor base and cowl are integrally mounted to agitator, and the unit is equipped with an adjustable support under motor base. Hinged weatherproof cowl on motor gives easy access to motor.



Porter Side-entering Agitator

Two-Dial Rotary-Type Process Timer

General Electric Company (Switchgear Division), Schenectady, New York, has announced a new two-dial rotary-type process timer which regulates the flow of products in catalytic processes such as production of high-octane gasoline, butadiene and toluene.

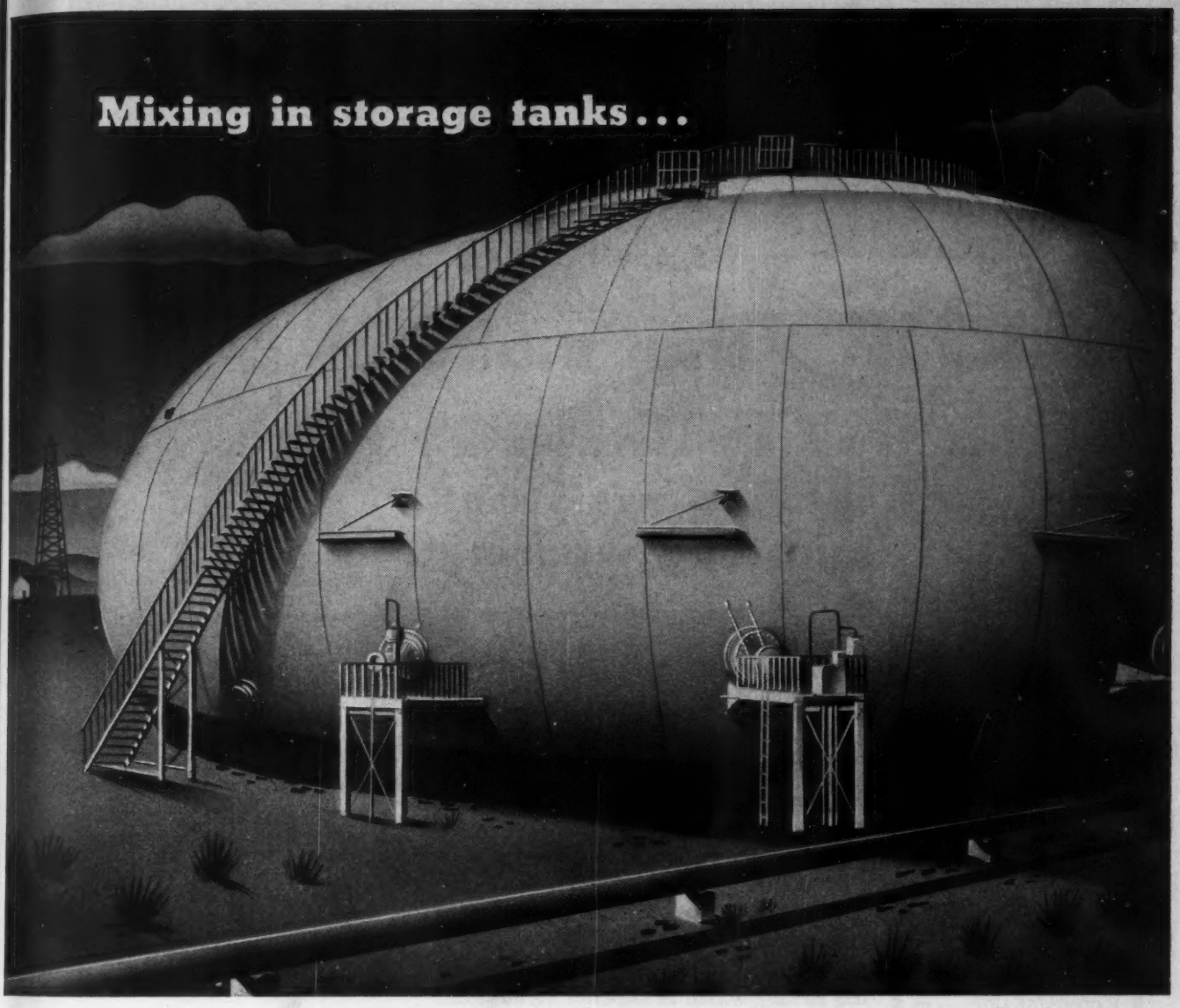
During the manufacture of these products, hundreds of accurately timed, sequential operations must be performed. Some of these operations involve the opening and closing of electrically operated valves, dampers, and other devices in a definitely timed cycle. Depending on the process requirements, a complete cycle of operations may require from 20 minutes to 3 hours, or more; from 18 to 75 devices may be controlled; and from 100 to 900 contact points or timing intervals may be needed.

These requirements are met by the new process timer in which each of the two dials has two concentric rings or rows of 224 contact points each—a total of 896. Each dial has a rotating contact arm. The arms are geared to a single shaft and can be driven through a clutch by a synchronous motor and adjustable gear train, or they can be operated independently from separate motors. A spare motor and a handwheel for operating the unit manually are also available. The circuit to the segments is made and broken through an auxiliary switch, not at the segments, and the unit will easily handle control circuits of 10 amperes, 125 volts.

Essentially a large motor-driven selector switch, this timer operates at a speed which may be selected to suit the process. It is arranged to complete the circuit to the controlled device or an alarm circuit as a moving brush selects each point. Flexible jumpers are provided for connecting between the segments and a terminal board. The jumpers are plugged to the segments which will provide the desired operating cycle, and all incoming control leads are brought to the terminal board.

The equipment is enclosed in a compact steel housing, with a window for viewing the timer segments and operating arm, and will line up with other con-

G-E Two-Dial, Rotary-Type Timer



Information supplied by "Petroleum Refiner"

Motor fuel, especially that for aviation, has to be thoroughly mixed as a final step in manufacture. Several different types of hydrocarbons are essential and tetra ethyl lead has to be added before all specifications can be met.

If left in storage the heavier of the hydrocarbons would seek the lower levels of the vessel. Turning these liquids over is done with mixing devices, propellers attached to motors by long drive shafts. The shafts pass through the cover plates at angles so the propellers will impart an off center thrust to the liquid. The result is a slow rotation combined with rapid bottom to top movement.

Three of these devices can properly blend the contents of a 100,000 barrel tank in three hours.

Blending precedes pumping to tank cars or vessels and assures specification motor fuel for each.

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These are instances of how each G-T Packing is specially prepared for long life in the precise range of services for which it is designed. To assure lowest year-round packing costs and best service, insist on G-T Packings . . . obtainable from your dealer.

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7. **EXPERIENCE . . . 80 years of manufacturing experience**
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G-T *self-lubricating* PACKINGS

G-E Process Timer. Rear view showing ease in changing taps.

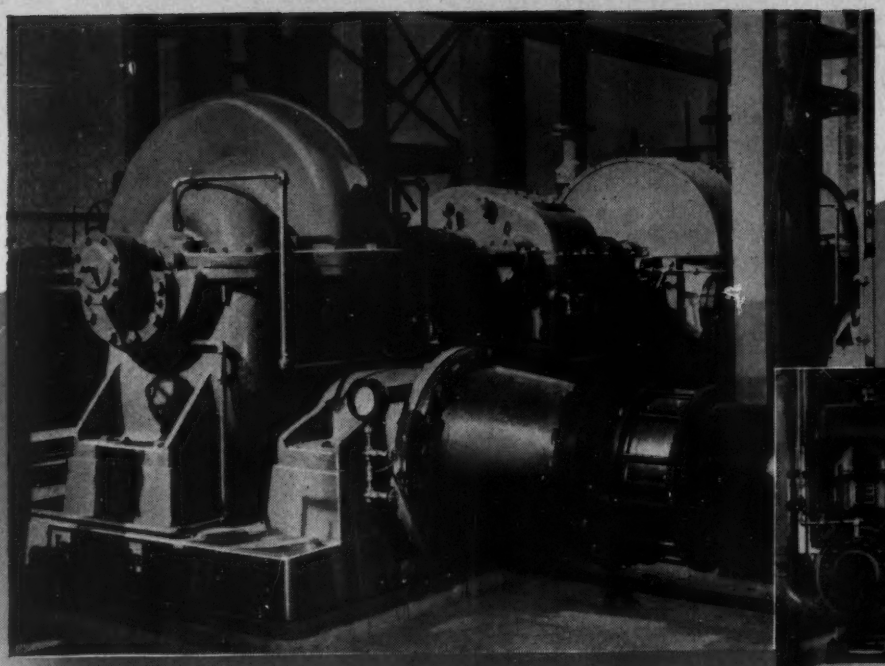
trol panels and instrument boards which may be required. The timer is designed to provide maximum flexibility of operation with a minimum of adjustments and maintenance. It can easily be adapted to control many chemical and industrial processes now operated manually and, therefore, without the safety which can be built into an automatic system.

Marine Type Rotary Pump

Blackmer Pump Company, Grand Rapids, Michigan, has perfected a marine type rotary pumping unit with built-in relief valve, for handling lubricating oil.

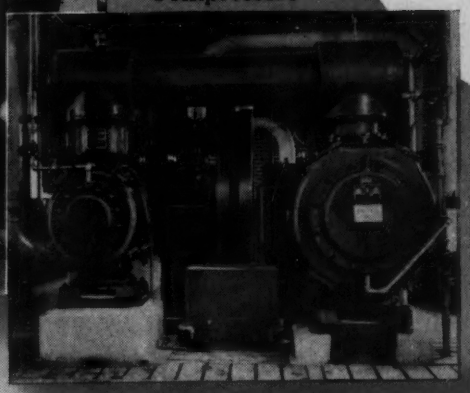
The outfit operates on the "Bucket Design," swinging vane principle, and has a capacity of 50 gallons per minute at a discharge pressure of 20 pounds. It is direct connected by means of a flexi-

Marine Type Rotary Pump



Water Supply Pumps

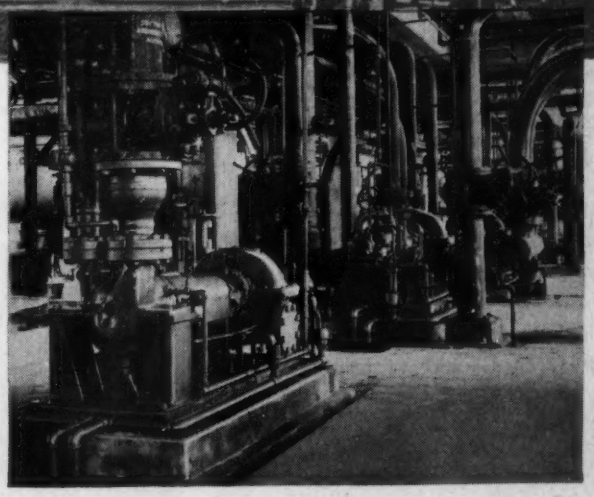
Compressors



I-R SERVES

Neches Butane Products Plant

Process Pumps



Tons of liquids must be handled and processed in the huge butadiene plant at Port Neches. Ingersoll-Rand Cameron pumps are doing their share in this plant, as they are in most of the butadiene and aviation gasoline plants now supplying our ever-increasing war needs . . . Pumps for process work, for water supply, for boiler feeding . . . Also I-R compressors and air tools.

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ble coupling to a 3-horsepower motor. Bearings are internal, anti-friction type. A split gland is used for ease in repacking.

The motor is supported by a bracket made of welded steel plate and bolted to a bulkhead. The pump is mounted vertically on the base of the bracket, permitting free access for lubrication and adjustments.

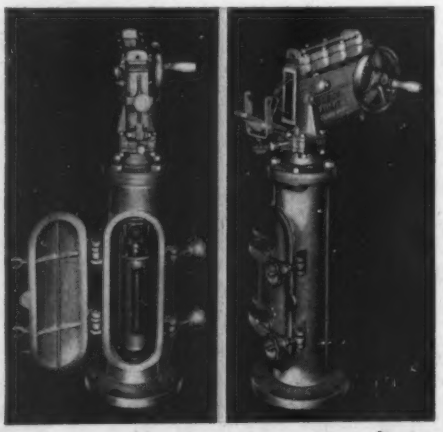
Tank Gauge

The "Oceco" Division of Johnston & Jennings Company, Cleveland 14, Ohio, announces a multiple-duty hand tank gauge which eliminates the necessity of gauging through an open hatch, with resulting loss of vapor and exposing the gauger to fumes.

This equipment consists of sampler-bob with a thermometer, a fingered tape guard, and a gauging tape that is reeled past a sight glass on top of the unit. Access doors are provided for both the lower and upper chambers. A gauging valve, operated with a knurled knob, isolates the upper from the lower chamber when closed, and the base of the unit is a standard 125-pound flange, which is drilled for mounting on a standard 4-inch gate valve.

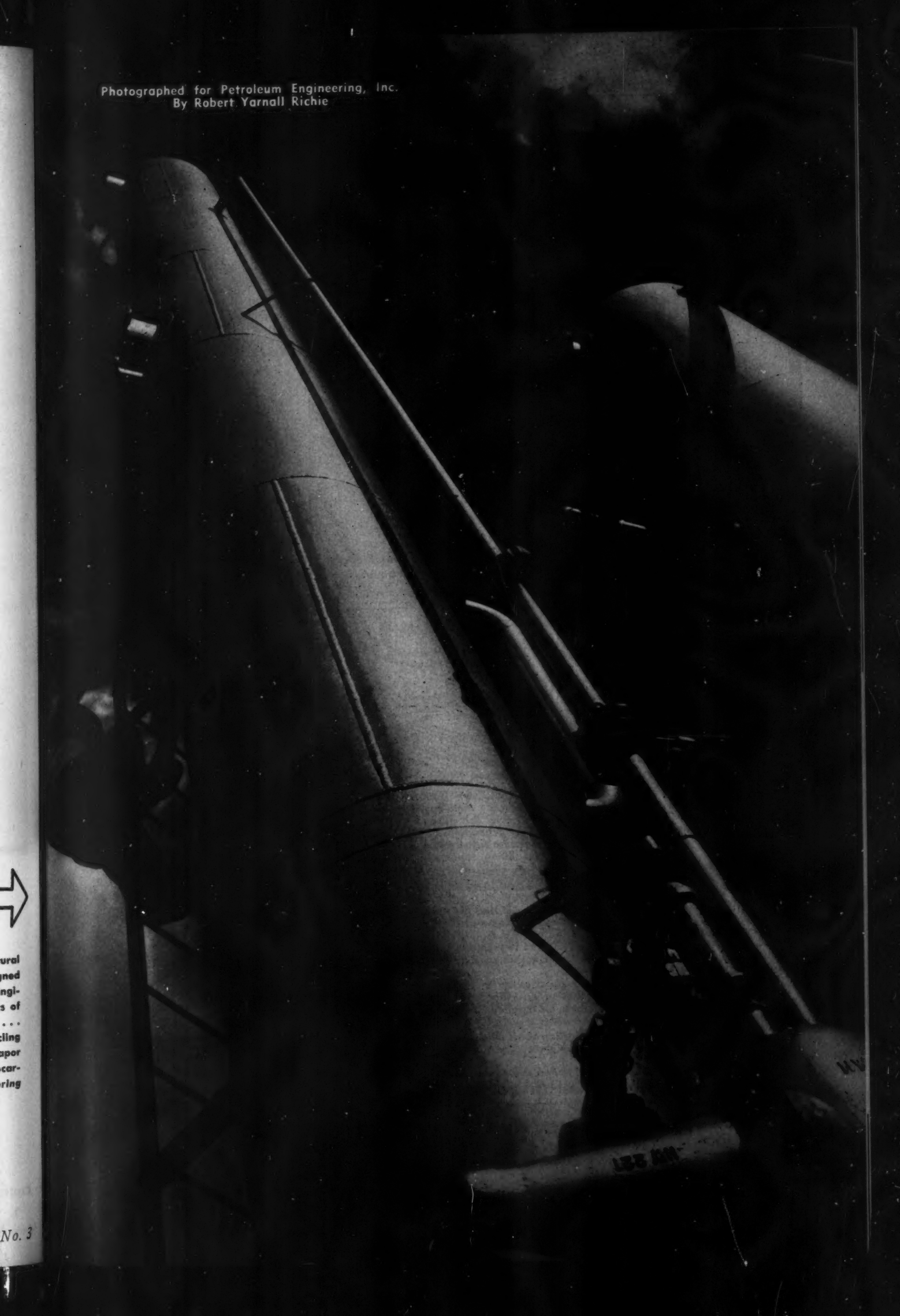
In operating the device, the gauger opens the 4-inch gate valve and lowers the sampler-bob into the tank.

When that portion of the tape, where the level of the liquid in the tank is expected to be found, comes into view in the sight glass on top of the "Gaugit," the gauging valve is closed with the knurled knob, thus preventing the escape of tank vapors. The tape access door is then opened, and gauging paste applied to a section of the tape. After the door has been closed again and the gauging valve re-opened, the tape is reeled out slowly until the sampler bob contacts the bottom of the tank. This opens the upper valve in the sampler bob, so as to take a sample of the tank contents as the tape is reeled in. The gauger stops reeling at the point where the gauging paste has been "cut," taking the reading, then closes the gauging valve, and opens the tape access door, and wipes the tape clean of paste. After the access door has been closed and the gauging valve opened again, the sampler-bob is reeled in, reclaiming the tape guard from the gate valve, until the bob hits the safety bumper in the sampler housing. The 4-inch gate valve is then closed,



Front view (left) of "Gaugit," showing sampler bob, thermometer and tape guard. At right is shown door through which paste is applied.

A view of one of the many natural gasoline absorption plants designed and constructed by Petroleum Engineering, Inc., in the past 15 years of continuous service to the industry . . . in design and construction of cycling plants, repressuring plants, vapor recovery plants and pure hydrocarbon plants. *Petroleum Engineering Inc. Offices: Tulsa, Houston.*


Photographed for Petroleum Engineering, Inc.
By Robert Yarnall Richie

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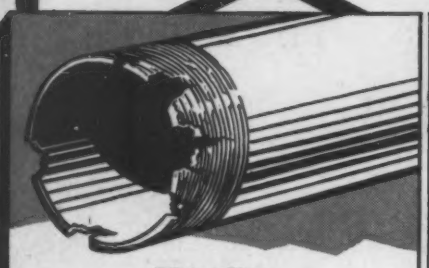
WeldOlets for butt welded branch connections.

ThredOlets for screwed branch connections.

Socket-End WeldOlets for socket-type branch connections.

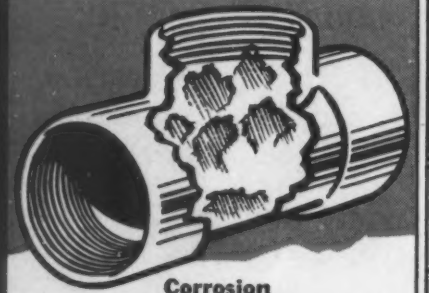


Threading

Threading weakens pipe walls as much as 40% — causes piping failures. WeldOlets, ThredOlets, eliminate threading of main pipe — make junction of full pipe strength.

Replacement

WeldOlets, ThredOlets practically eliminate fitting replacement. Properly installed they provide trouble-free, leakproof junctions.



Corrosion

Because drop forging improves metal structure of WeldOlets, ThredOlets, they resist corrosion better than ordinary types of fittings.

Improved Right-Angle Outlet

WeldOlets, ThredOlets provide leakproof, right-angle branch pipe outlets of full pipe strength; improve flow conditions; eliminate worn threads; bolt tightening; reduce need for fitting replacement; corrosion.

WeldOlets, ThredOlets and Socket-End WeldOlets are suitable for all commonly used pressures and temperatures in every type of piping system. They are installed either before or after erection of the main line and always with ease and economy. They are equally well adapted to prefabricated or "on-the-job" assemblies. Their patented, funnel-shaped intake aperture improves flow conditions, reduces turbulence and friction.

Carried in stock for all standard pipe sizes up to 12" in size-to-size and reducing sizes—up to 24" on special order. Stock fittings are drop forged steel, but to meet unusual conditions can be supplied in Monel, Everdur, Toncan Iron, wrought iron, etc.

Bulletin WT31 gives detailed information about all the advantages of WeldOlets, ThredOlets and Socket-End WeldOlets. Write for a copy today.

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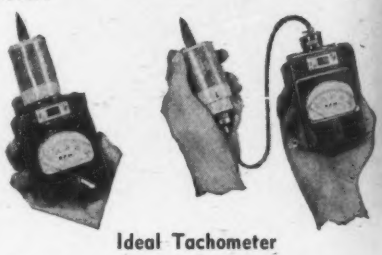
the door to the sampler chamber opened, the temperature recorded, and the contents of the sampler-bob drained into a container through a valve in the bottom of the sampler, or returned to the tank.

Self-Energized Tachometer

Ideal Commutator Dresser Company, 1525 Park Avenue, Sycamore, Illinois, announces a self-energized tachometer that can be used either as a "Hand" type or "Separable" type.

The outfit consists of a small generator coupled electrically to an electric meter. The generator itself consists of a small, permanent magnet rotor which is mounted on precision sealed ball bearings and capable of continuous operation at any speed within limit of the meter.



Ideal Tachometer

The meter or indicating instrument is a rectifier type, including a sturdy D'Arsonval movement. According to the manufacturer, it is capable of withstanding a momentary overload up to four times the maximum speed indication without damage. The meter is provided with two scales, "Hi" which indicates the maximum reading obtainable, and a "Lo." A small switch incorporated in the meter case provides for easy changing scales.

Generator and meter are made as distinctly separate elements and are coupled together by a precision made bayonet lock. The units may be used together, or for many applications including permanent mounting, the generator and meter may be separated, and connected only by a two-conductor electric cord. A five-foot cord complete with coupling plug is provided, but a cord up to several hundred feet long, of proper size wire, can be used without introducing an appreciable error in scale reading.

The tachometer is available in two sizes: for 0 to 2500 rpm, and 0 to 5000 rpm.

Electronic Feed Water Control

Combustion Control Corporation, 77 Broadway, Cambridge 42, Massachusetts, has introduced an electronic feedwater control, under the trade name of "Fireye," Series P156N, for maintaining constant boiler-water levels automatically, and for guarding against low-water hazards. The control has been designed to provide the average power plant with low-cost automatic control through simplified, long-life equipment.

For automatic feedwater pump control and low-water protection, Type P156N is used with probe fitting Type H53. The probe fitting may be mounted parallel to the water column, or directly on the boiler, and is wired to the electronic control. Three probes within Type H53 mark boiler feed-water pump on and off levels and a low-water danger point. The top and middle probes determine the high and low levels at which the boiler feed-water pump is

Superintendent: **"Jim says the coils in Number 6 tower will have to come out again."**

Chief Engineer: **"For that condition we have over there I believe we are going to have to change to alloy tubes."**

Chief Chemist: **"I think you are right—that crude we are running is going to give us plenty of corrosion trouble."**

Maintenance Engineer: **"Hand me that REFINERY CATALOG" . . .**

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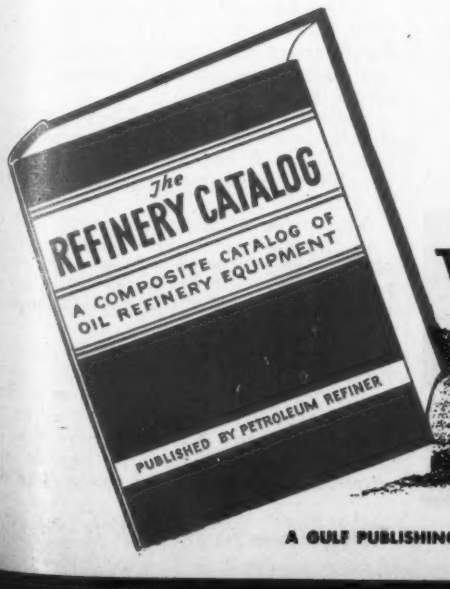

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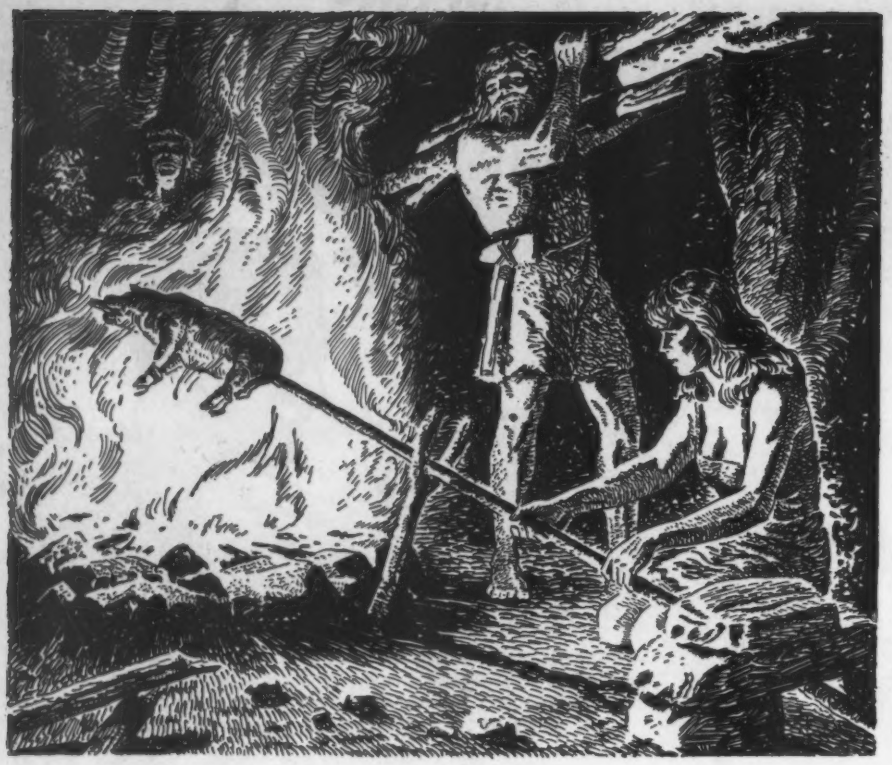
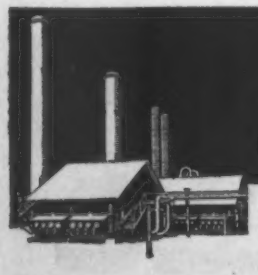


Civilization's progress paralleled the advances of man in the application and control of fire for comfort and health. The use of fire for the preparation of food gave civilization a great impetus. Through the centuries, fire has continued to be the dynamic for progress in every pursuit. Without the scientific application of heat, petroleum refining might never have achieved its colossal importance. Twenty years ago, Alcorn pioneered in the engineering development of efficient, economical heaters for petroleum processing. Alcorn installations in major refineries of the world are proving their merit. Alcorn knowledge and long experience are at your disposal for the solution of your heating problems.



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Combustion Company

SCHAFF BUILDING, PHILADELPHIA
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turned on and off to maintain constant water level. When water falls below the middle probe, the control closes the electrical circuit controlling the pump and water feeds into the boiler. When the level rises to the top probe, the water itself acts as conductor of a minute electrical current which operates the electronic control and turns off the pump. The pump remains inoperative until boiler water again falls to the level of the middle probe. The lowest probe defines the danger point below which boiler water must not fall. Should water drop below this safety probe, the control immediately shuts off the fuel supply and sounds an alarm.

Types are available also for automatic pump control only, or for low-level protection only.

Controls are supplied as standard for boiler pressures to 300 pounds and for operation from a supply of 115 or 230 volts A.C. 60 cycles. The equipment governs solenoid valves, small horsepower pump motors, or pump motor magnetic starters. The probe housing is furnished in either cast or malleable iron, and the electronic control in a weatherproof pressed steel housing, both attractively finished in green crystal.

Safety Faceshield

Mine Safety Appliances Company, Pittsburgh, Pennsylvania, has developed the M.S.A. Type "H" faceshield for quick attachment to Type "K" M.S.A. skullgard protective hat.

The Type "H" faceshield, providing protection for the face against flying particles, is readily assembled to "K" skullgards in the field, making possible easy adaption to the many skullgards now in service.

Positive attachment is assured and the faseshield can be removed just as quickly as it can be attached, thus permitting the use of the skullgard alone at any time.

Clear, transparent visors, 14 inches wide by 6 inches long, of the best commercially available plastic, are employed. The visors are fastened to the combination unit in a novel but very practical manner, affording a simple and easy means of replacement. Visors are interchangeable.

The fiber visor retaining strap is mounted on a pivotal joint, allowing upward or downward movement of the faceshield to the position desired by the operator.

Fire Shield

American-LaFrance-Foamite Corporation, Elmira, New York, is introducing the Foamite fire shield for fighting fires out in the open, in tank farms or about refineries.

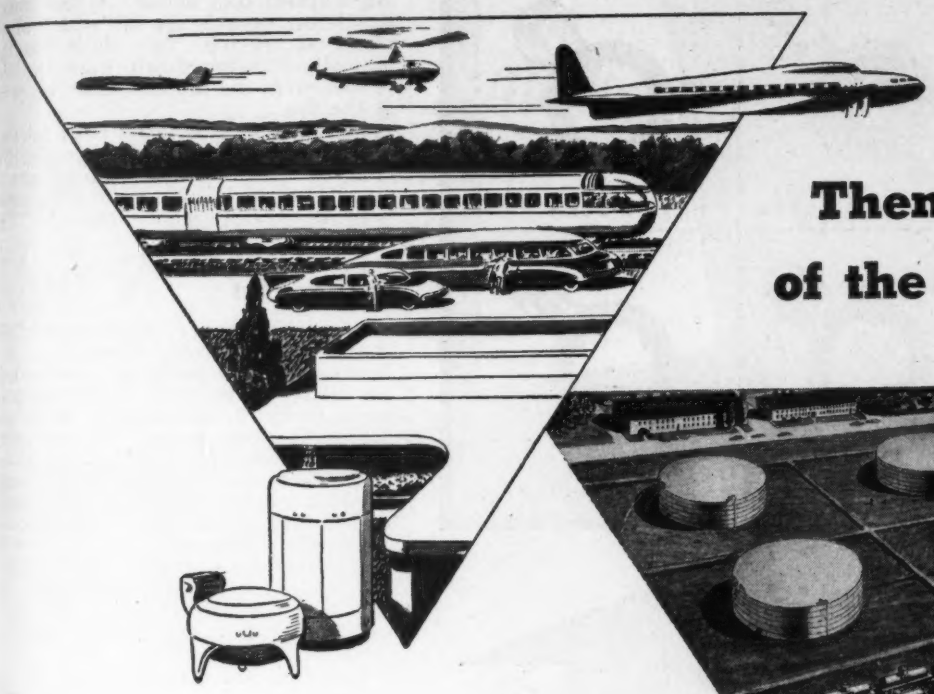
Between the front and back plates of the Foamite fire shield is an insulating mineral wool blanket, one inch thick, capable of withstanding a temperature of 1200° F.

The three observation ports and the four nozzle ports are each equipped with pivoted cover doors controlled from the rear of the shield. Sturdy anchoring chains are provided for securing playpipes in place.

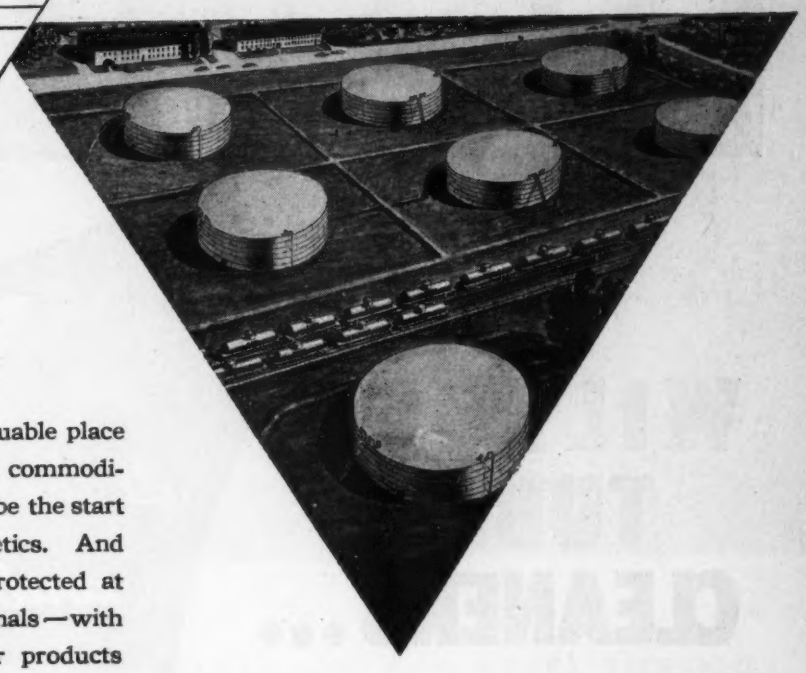
At the base of the shield are three hinged skirts, which give way readily upon meeting any ground unevenness.

The wheel carriage is bolted to the shield body, so that the parts may be packed knocked-down, to permit of a minimum transportation space. The rear

If this is your picture of the future...



Then this is part of the picture too!



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6 NO CONTAMINATION. *Separate pumps, lines, storage zones for dissimilar commodities.*

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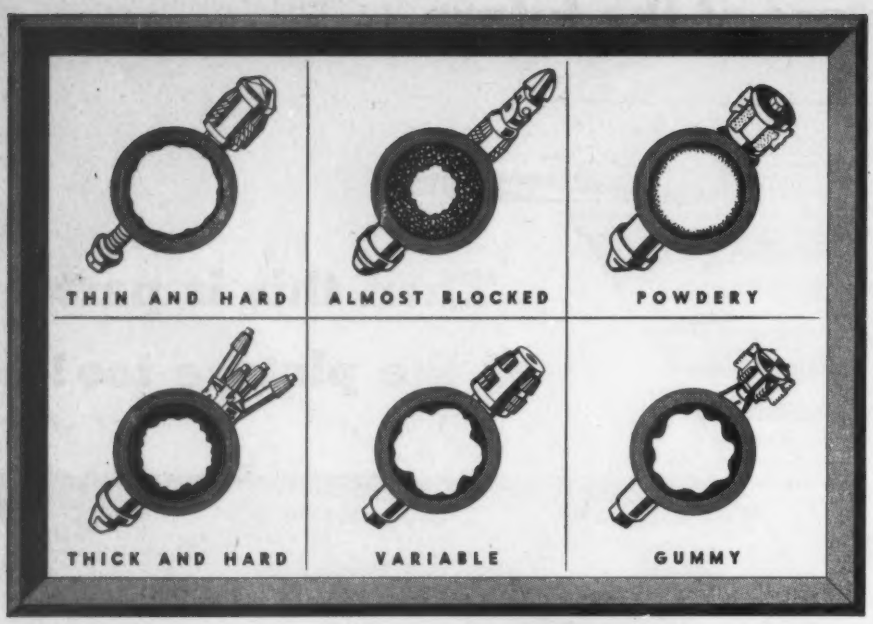

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supports of the fire shield give stability. They are hinged to fold against the shield body for shipment, and when being wheeled into action. A full length handle bar extends the full width of the shield at the top. Two short handles, normally hanging down, may be used to maneuver the fire-shield at the scene of the fire.

The Foamite fire shield is of particular value in the close-up fire fighting required when carbon-dioxide gas is used. The shield affords ample protection. It is 79½ inches high by 75¾ inches wide overall.

Safety Hat

Davis Emergency Equipment Company, Halleck Street, Newark 4, New Jersey, has now perfected a new hard hat offered to industry under the trade name Hedgard, built to give three-way protection to its wearer. The top of the crown is reinforced for direct blows. The side of the crown is built to stand glancing blows and the brim is made flexible yet strong so that it will not crack when dropped.

A patented moulding process and a new compounding process makes the hat shatter proof. There is no chance that part of the crown will protrude into the head.

The blow is first absorbed on the crown which has a "give and deflect action." It is further absorbed in the new cradle and sweatband construction which acts as a shock absorber. The hat will stand better than 8 pounds dropped 10 feet. Weight is slightly more than 13 ounces, depending upon the type of sweatband used..

The sweatband is replaceable and may be washed in water or dry cleaned. The whole hat may be sterilized with steam.

Portable Extinguisher

Randolph Laboratories Incorporated, 8 East Kinzie Street, Chicago, Illinois, has developed a portable, light-weight fire extinguisher that requires only one hand in operation.

This model FF-4 features a self-aimed, fixed discharge horn and a thumb operated trigger valve that releases a blanket of carbon dioxide.

In use, the operator of the extinguisher, grasps the arched-steel handle as though aiming a .45 revolver, while the thumb presses the trigger directly above. The fire-resistant horn is permanently regulated to fixed firing position.

This type fire extinguisher is well adapted for small "spot" fires because of its portability.

Floor Cleaner

Fidelity Chemical Products Corporation, 430 Riverside Avenue, Newark, New Jersey, is marketing a new oil and grease absorbent floor cleaner. The product is listed by Underwriters' Laboratories as a class 1 non-combustible absorbent for reducing fire and slipping hazards and for cleaning floors.

Though granular in form, the material is non-abrasive and will not damage machinery or working parts due to abrasive action. It is also odorless, non-poisonous, and non-injurious to skin, clothing, or flooring, according to the manufacturer. It may readily be spread by hand and used on any type of floor surface.

TALON'S ELECTRIC WELDED STEEL TUBING USED FOR MANY APPLICATIONS IN HIGH OCTANE GASOLINE PLANTS

Our mighty war birds have tremendous power and "stratospheric" performance for which credit is due to the product of America's great octane gasoline plants.

The process of producing high octane gasoline, which sends our planes faster, farther, and higher, involves tremendous pressure and extreme heat. Because Talon's Electric Welded Steel Tubing stands up under this gruelling operation, it is used with confidence in heat exchangers, boilers, condensers, and superheaters. The concentricity, uniform wall thickness, and ductility of Talon's Tubing help speed original installation work. Once on the job, it stays put, resisting the combined ravages of heat and pressure.

Investigate the possibilities of using Talon's Electric Welded Steel Tubing in your business for pressure or mechanical applications.

PRESSURE MECHANICAL

TALON . . INC.

STEEL TUBE DIVISION OIL CITY, PENNA.

THERE IS WHY IT IS GOOD BUSINESS TO SEE THAT YOU GET

BATES-GRATES

FOR OPEN STEEL FLOORING

That scraper edge on the Bates open steel flooring cross bar is cleaner and safer. You grasp the idea from even a quick glance at the picture. Yet it doesn't cost you a cent more.

You get those extra advantages because the Bates patented process builds a fillet from displaced metal—in addition to the clean scraper tread of the "Hex" cross bar, giving you smoother, cleaner, larger welds *and stronger flooring.*

Write for copy of well-illustrated, 8½" x 11" CATALOG NO. 43-44. It gives complete data on fillet welded Open Steel Flooring and Stair Treads.

WALTER BATES COMPANY, INC.
JOLIET • ILLINOIS
OPEN STEEL FLOORING • STAIR TREADS

☆ BUSINESS NOTES ☆

S. D. Hicks & Son Company, Boston, Massachusetts, has appointed J. S. F. Carter engineer in charge of design and engineering for its process division, and has opened a New York Branch office at 51 East 42nd Street.

J. S. F. Carter

The company has plants at Hyde Park and East Boston, Massachusetts. The former handles equipment for complete chemical and alcohol plants and synthetic rubber plants, the design of which will be supervised by Carter. This shop fabricates all types of equipment in sheet and plate copper, steel, stainless steel, monel, nickel and aluminum. The East Boston plant is a machine shop available for the handling of components for the fabricated items.

Carter is a graduate of Sheffield School at Yale University. He has been chief design engineer of Cherokee Ordnance Works built by Heyden Chemical Corporation at Danville, Pennsylvania. Previous to this he was associated with The Lummus Company and DuPont. Associated with Carter are Watson K. Mawby, chief draftsman at the Cherokee Ordnance Works, and Alexander J. Nansen, engineer, previously with Heyden Chemical Corporation and The Lummus Company.

Elliott Company, Jeannette, Pennsylvania, announces appointment of R. W. Owens as assistant to Grant B. Shipley, the company's president. A graduate of the University of Illinois with a B.S. degree, Owens received an M.S. degree from the same university in 1915 before joining the staff of Westinghouse. Successively a section engineer, manager of the industrial motor engineering department, general manager of industrial engineering, and manager of the motor division in complete charge of engineering, manufacturing and sales, he has had 28 years of practical design experience. He is a member of the American Institute of Electrical Engineers.

Arthur G. McKee & Company, Cleveland, Ohio, announce the appointment of Thomas G. Elder as an engineering executive in its petroleum refining division. During the past three years, Elder was superintendent of manufacturing for The National Refining Company, in which position, besides directing all manufacturing operations, he also handled the building of new aviation gasoline plant facilities in Coffeyville, Kansas. During the war period, he has been active in the petroleum refining war program, having been a member of the Petroleum Industry War Council sub-committee on postwar adjustments and a member of the American Petroleum Institute on the protection of petroleum facilities. Prior to joining the National Refining Company, he was with Shell Oil Company for nearly 23 years holding various operating and executive positions, including those as manager of the company's East Chicago, Indiana, refinery, and as assistant superintendent and superintendent of both its Houston, Texas refinery and Woodriver, Illinois refinery.

N. M. Barnett

R. T. Cowan

Steel and Tube Division of Talon, Inc., Oil City, Pennsylvania, has appointed Robert A. Campbell sales manager. Campbell has been assistant sales manager for Ohio Seamless Tube Company the past seven years, and previously with Standard Tube Company and Republic Steel Corporation, Steel and Tube Division. Work on an addition to the company's plant at Oil City is progressing satisfactorily and should be completed within 60 days, an announcement said.

R. A. Campbell

Bailey Meter Company, Cleveland, announces appointment of N. M. Barnett as Manager of its Chicago office, 1041 Marquette Building. He succeeds M. Greenberg whose resignation became effective February 1. Barnett is a Mechanical Engineering graduate of the University of Kentucky and has been connected with Bailey Meter Company for over 20 years. He was manager of the company's Detroit office prior to his transfer to Chicago. He has had a wide experience in power plant engineering and combustion work, particularly with reference to the solution of metering, controlling and regulating problems.

The vacancy created by Barnett's transfer to Chicago has been filled by Ralph T. Cowan, formerly of the Detroit and Cleveland sales offices of Bailey Meter Company. Cowan, who is a graduate of Case School of Applied Science, has specialized in the problems involved in applying metering and automatic control equipment to power plants and industrial processes. Company headquarters in Detroit are at 226 Curtis Building.

Allegheny Ludlum Steel Corporation has advanced Russell M. Allen, general manager of sales, to vice president in charge of sales. Allen started with Allegheny Steel Company in 1920 as a production man in the mill. After two years he entered the sales department and represented the company at Detroit and Chicago before being recalled to Brackenridge, Pennsylvania, as assistant sales manager, continuing in that position after the merger that was the for-

ANACONDA COPPER

gives Long Life to Lube Oil Coolers

Assembled view of Ross B C F Cooler, Duplex Construction

IN THIS Ross B C F Duplex Cooler, long life is added to its efficiency through the use of Anaconda Metals. The heat exchanger tubes are Anaconda Admiralty throughout. Both the upper and lower shells are Anaconda Seamless Drawn Copper Tubes. Shells may vary in length depending on rated capacity, and are brazed to the cast bronze tube sheets. Bonnets and shell hubs are also cast bronze.

The high thermal conductivity of these materials, plus their resistance to corrosion, makes possible continuous service with a minimum of attention in cooling lube oils in engines, turbines, reduction gears and machine tools; also for cooling cutting oil, quenching oil, transformer oil, and engine jacket water.

The performance of Anaconda Copper and Copper Alloys in equipment such as Ross Coolers is evidence of the dependence that you can place in these metals. Anaconda engineering assistance is available for meeting heat transfer problems of all types, under all operating conditions. 44104

ANACONDA

Anaconda Copper & Copper Alloys

THE AMERICAN BRASS COMPANY—General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company—In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

Easier Way to Clean Oil Filter Screens

The next time you clean muck-encrusted stainless steel filter screens, try the more effective Oakite way. You will be surprised to see how THOROUGHLY and QUICKLY scale, burnt oil, tar, sand, Fuller's Earth and other deposits are removed!

First soak screens as directed in recommended Oakite alkaline degreasing solution. Then follow with immersion in tank containing solution of an Oakite acid-type detergent, neutralize and rinse. You will find filtering capacity is restored, and unit can be returned to service without delay.

Data FREE on Request

Further data on this and other maintenance work such as cleaning heat exchangers, are yours FREE for the asking. Write TODAY!

OAKITE PRODUCTS, INC.
508 Thames Street, New York 6, N.Y.
Technical Service Representatives Located in All Principal Cities of the United States and Canada

R. M. Allen

P. E. Floyd

mation of the Allegheny Ludlum Steel Corporation in 1938. He has been general manager of sales since 1940. P. E. Floyd, formerly sales manager in the Chicago district, has been named assistant general manager of sales. He recently was released by WPB for which he was chief of the stainless section of the steel division at Washington.

Westinghouse Electric International Company, New York, has appointed Edward J. Herzog manager of its oil and mining division, to succeed Russell D. Heath, who resigned to organize his own company. Herzog recently returned from Venezuela where he was regional supervisor for the Caribbean area. In his new position he will direct all sales to the oil and mining industries outside continental United States and Canada. He joined Westinghouse in 1928, immediately after receiving his electrical engineering degree from University of Illinois. He went to Trinidad in 1940 and moved headquarters to Caracas, Venezuela, in 1942.

Houdry Process Corporation, Wilmington, Delaware, is expanding its laboratory facilities. The addition will double the working space to the main research laboratories of Catalytic Development Corporation, Linwood, Pennsylvania.

"The continuing research into the catalytic transformation of petroleum has brought about the essential need for increasing our research facilities. To this end an extension of brick and reinforced concrete is being added to our present building," Houdry said. "The new extension will permit additional working space to accommodate chemists, technicians, engineers and assistants. Upon completion, most of the corporation personnel will be headquartered at the Linwood laboratories, under the corporation's operating subsidiary, Catalytic Development Corporation."

Lukens Steel Company, Coatesville, Pennsylvania, has appointed Arthur J. O'Leary assistant manager of sales, and George W. Eshleman assistant to the manager of sales. O'Leary has been with the company since 1929, transferring

A. J. O'Leary

G. W. Eshleman

PLIBRICO
Jointless FIREBRICK

The Answer to Your Refractory Problems!

FOR boilers and stills—for patching and repairs—for entire walls and complete relining—Plibrico Jointless Firebrick is the dollar-saving, trouble-saving refractory that refineries everywhere are adopting.

Plibrico forms a solid, monolithic lining that eliminates the weak joints of laid-up fire brick construction. Flexo-Anchors prevent bulging. No special shapes are required; Plibrico comes in moist, plastic form and can be readily moulded to any shape. Your own maintenance men can install it or we furnish complete installation service.

For extreme conditions, there is the Plibrico sectionally-supported air-cooled wall. And the Plibrico suspended arch for boiler arches and still roofs. Both are erected without special tile or heavy castings.

These catalogs cover your requirements.

Here is the complete story of Plibrico linings, arches, air cooling, etc. Ask for your Plibrico catalog. Specify whether operating H.R.T. or water tube boilers.

PLIBRICO JOINTLESS FIREBRICK CO.
1803 Kingsbury St., Chicago, Illinois

ESPECIALLY RECOMMENDED FOR USE IN THE

COPPER SWEETENING PROCESS

Nichols
TRIANGLE BRAND
COPPER SULPHATE

is preferred by leading refineries because of its high copper content, dependable uniformity and exceptional purity and freedom from foreign and inert matter.

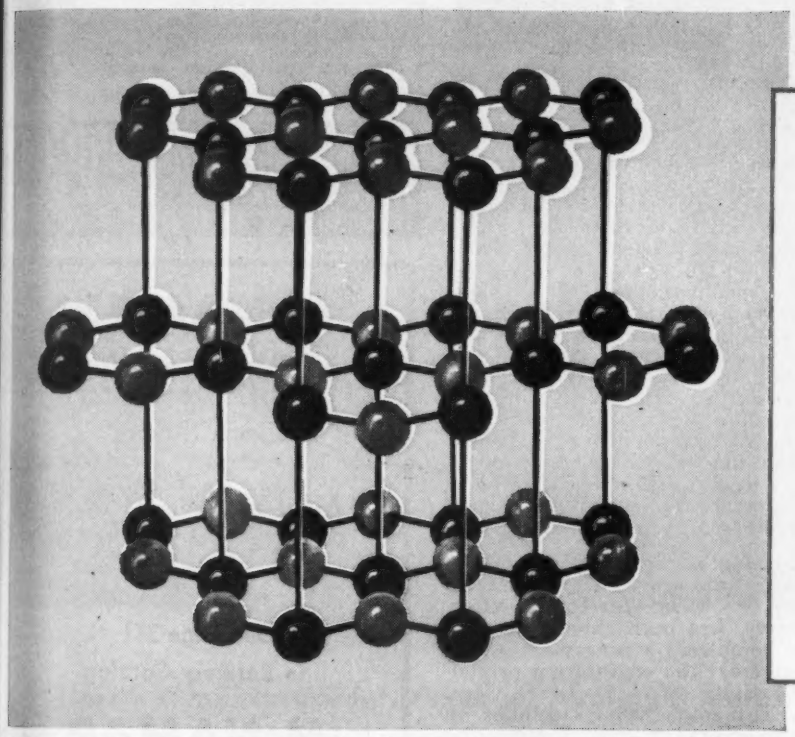
99% + PURE

Quotations on request, on any quantity required. Shipments can be made from our nearest plant.

PHELPS DODGE REFINING CORP.
40 WALL STREET, NEW YORK
230 N. MICH. AVE., CHICAGO

"National" Electric Furnace

GRAPHITE



Crystal Model of Graphite, showing its atomic structure. National Carbon Company research laboratories, working with the most modern X-ray spectrometry apparatus, conduct continuous studies in crystal analysis of graphite.

Pipe and Tubing • Fittings • Pumps • Valves • Brick, Slabs and Tile • Towers: Absorption, Fractionating and Scrubbing • Bubble Caps and Trays • Raschig Rings • Heat Exchangers of All Types • Bearings: Oilless Type • Ground Rods for Electrolytic Protection • Sparge Pipes • Vallez Filter Plates • Porous Carbon for Aeration and Diffusion.

TREMENDOUS GROWTH of the processing industry's uses of "National" graphite made in the electric furnace, is strikingly brought home by the above list of products.

Thorough control of graphite's extraordinary properties during manufacture... control based on years of research and experience... accounts for the increasing uses of these products. Some of the most important of such properties for the processing industry are *strength, high heat transfer, resistance to practically all corrosive liquids and vapors, freedom from contamination, wide range of porosity or imperviousness, self-lubrication, and ease of machining and fabrication.*

Some of the products listed are carbon; others "Karbate" specially treated carbon or graphite stock. However, the material used is always that which gives you the lowest processing or replacement costs consistent with the physical and chemical requirements of the application.

For detailed information, write for Catalog Section M-8000 "Industrial Applications," to National Carbon Company, Inc., Cleveland 1, Ohio, Dept. 30C.

★ BUY UNITED STATES WAR BONDS ★

The words "National" and "Karbate" are registered trade-marks of National Carbon Company, Inc.

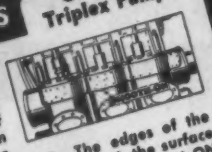
NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

CARBON PRODUCTS DIVISION, Cleveland 1, Ohio UCC New York, Pittsburgh, Chicago, San Francisco

SMOOTH-ON
REPAIR
RECORDS

Cracked Triplex Pump

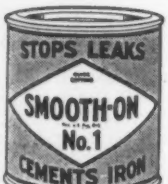


A patch plate was shaped to match the curvature of the pump block in order to reinforce the SMOOTH-ON repair. The edges of the crack were then slightly beveled, the surface was cleaned, and a putty of SMOOTH-ON No. 1 was forced into the crack by tamping with a hammer. After the patch was attached to the pump block by machine screws, the repair was completed.

FOLLOW THIS SERIES OF SMOOTH-ON SAVINGS

Many SMOOTH-ON repairs are even simpler than this, for short cracks or cracks which are not under pressure do not require reinforcement when repaired with SMOOTH-ON No. 1. And SMOOTH-ON does not require the application of heat or dismantling of apparatus, so that repairs made with SMOOTH-ON are frequently quicker and more economical than by any other means. SMOOTH-ON repairs are durable, too, as has been proven by literally hundreds of thousands of repairs to plant equipment which have been accomplished by SMOOTH-ON. For stopping leaks, sealing cracks, and tightening loose parts, think first of SMOOTH-ON . . . and keep a can handy.

Buy SMOOTH-ON in 7-oz., 1-lb., or larger containers from your supply house, or if necessary, from us. For your protection, insist on SMOOTH-ON, used by engineers and repair men for over 49 years.



FREE

REPAIR HANDBOOK SHOWS HOW

40 pages, 170 diagrams, and simple concise instructions for practical repairs to plant equipment, pipe lines and structures. A necessity in every plant. Your copy sent FREE if you fill in and return the coupon.

SMOOTH-ON MFG. CO., Dept. 11
570 Communipaw Ave., Jersey City 4, N. J.
Please send SMOOTH-ON HANDBOOK

Name.....

Address.....

3-44.....

Do it with
SMOOTH-ON

from the operating to sales department in 1931. During 1941 and 1943 he was in Washington with the War Production Board. Eshleman has been with the organization since 1927 and in the sales department since 1935.

Lebanon Steel Foundry, Lebanon, Pennsylvania, has opened a Southwestern district office at 1505 Commerce Building, Houston, in charge of Herschel J. Wood, who will handle engineering, sales and service to the company's customers in the Southwest. Wood formerly was associated with Elastic Stop Nut Corporation of America. His appointment was effective February 1.

H. J. Wood

Condenser Service and Engineering Company, Hoboken, New Jersey, announces that Harold S. Bell has become associated with that organization. Bell, who is author of "American Petroleum Refining," for the past 18 years has acted as consultant, designer and construction engineer for many refining companies in the United States and abroad. He was interned with the diplomatic staff in Italy in 1941 and upon his return on the exchange ship in May, 1942, was assigned to the Board of Economic Warfare as consultant to the oil division and thereafter was a member of a special mission to Australia to investigate possibilities of developing shale or other oil substitutes.

Leach Manufacturing Division of Condenser Service and Engineering Company, 95 River Street, Hoboken, New Jersey, has been announced as a recently completed arrangement which brings together the engineering personnel and facilities of C. H. Leach Company and manufacturing facilities of Condenser Service and Engineering Company, for design and manufacture of heat exchangers for the petroleum and chemical industries.

The B. F. Goodrich Company, Akron, Ohio, has appointed H. W. Catt manager of the chemicals and pigments department of its purchasing division. He succeeds Dr. Victor E. Wellman, who becomes director of purchases in the company's newly created chemical division. Catt is a graduate in chemical engineering from University of Illinois, and having joined the company in 1929, had 10 years in chemical research and rubber compounding before transfer to the purchasing department in 1939.

Jones & Laughlin Steel Corporation, Pittsburgh, has advanced William J. Creighton to executive vice president, and Adam J. Hazlett to general manager of sales. Creighton entered the em-

CORRECTION

In the Shand & Jurs Company advertisement on page 46 of this issue the Regulator illustrated is incorrectly identified as Fig. ST-722. The correct identification is Fig. ST-772, and the publishers gladly make this correction of the typographical error.

SPECIFICATIONS
for a
GOOD COOLING TOWER
TREATMENT

1. Kill existing algae (all types).
2. Prevent future growth of algae.
3. Inhibit Corrosion.
4. Prevent scale formation.
5. Slowly remove scale and corrosion now in system.
6. Adaptable to filtration or "sludge" settling.
7. Simple color test for correct proportioning of chemicals (adaptable to automatic photo-electric proportioners).
8. PH control.
9. Manufacturers' laboratory service.
10. A 100% chemical compound.

Write . . . Wire . . . Phone

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McNAMAR
Steel Plate
Fabricators and
Contractors
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Products Storage
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Pressure Vessels
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For more information
See Page 371
in Refinery Catalog
McNAMAR
BOILER & TANK CO.
Tulsa, Okla. — Salem, Ill.

BAKOGRAPH
BAKORINGS
SAVE LINERS

Non-scoring plastic material is practically self-lubricating, hence temporary loss of lubricant will not affect the life of the liners or piston. Grit or scale become embedded in the plastic. Do not scrape liner as with metal rings.

Basic material made by General Electric Co.

Leading companies have proved lower cost per hour of service.

QUICK DELIVERY . . . WRITE FOR FOLDER AND PRICES

BAKORING
INCORPORATED
1020 HOUSTON, AVENUE
HOUSTON, TEXAS

"Crusher Test" proves FOAMGLAS* is strong

Here's a moistureproof, fireproof insulating material with high crushing strength

Just how strong is Foamglas? This has been answered by tests made in Armstrong's Laboratories on this sensitive, accurate Baldwin-Southwark Universal Tester. When tested on all faces, Foamglas blocks have an average compressive strength of 150 pounds per sq. in. Thus, this new, low-temperature insulation can be erected without framing members to form self-sustaining walls and partitions in cold-room construction.

Proof against moisture is a second important feature of Armstrong's Foamglas. The material is composed of thousands of tiny cells—and each cell is completely isolated from adjoining cells by thin glass walls. Hence, neither moisture nor vapor can penetrate Foamglas—so it's just as efficient years later as the day it is erected.

Proof against fire. Since Foamglas is pure glass, it is absolutely fireproof. In many types of refrigerated construction—particularly in marine work—this is an extremely important requirement of the insulation.

Add them up—moistureproof, fireproof, and high structural strength, plus insulating efficiency and easy handling—and you have good reason for investigating this new, low-temperature insulation.

Write today for your free copy of the folder, "Armstrong's Foamglas," which gives complete physical data. Address Armstrong Cork Company, Building Materials Division, 7503 Concord St., Lancaster, Pennsylvania.

PHYSICAL PROPERTIES

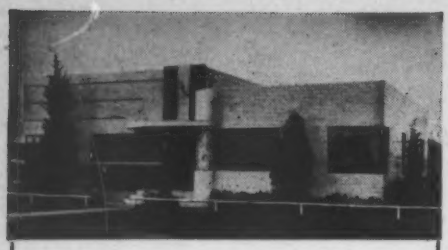
Average crushing strength,	150 lbs. per sq. in.
Modulus of rupture	90 lbs. per sq. in.
Modulus of elasticity,	163,000 lbs. per sq. in.
Impact resistance	66 foot-pounds
Absorption (24 hr. immersion in water),	0.4% by volume, 2% by weight (all at surfaces)
Permeability	0
Capillarity	0
Volume change with moisture	0
Conductivity (K at 70° F.),	0.45 B.T.U. per hr. per sq. ft. per °F. per in.
Specific heat	.16-.19 per lb. per °F.
Coefficient of expansion	.0000046

* Trade-mark, Pittsburgh-Corning Corp.

ARMSTRONG'S FOAMGLAS

A product of Insulation Headquarters

CORKBOARD • MINERAL WOOL BOARD • CORK COVERING



Now Offering All or Any Part of these

3 Complete REFINERIES

Lynch Refining Co.
KILGORE, TEXAS

Olney Refining Co.
OLNEY, TEXAS

Evansville Refining Co.
EVANSVILLE, IND.

Write for Our Catalog

Immediate Deliveries

NO Priorities

•

Refinery Equipment, INC.
UNION AVE. AT 21st STREET
TULSA, OKLA.

A. J. Hazlett

W. J. Creighton

ploy of the company as a clerk in 1900 and became financial vice president in 1928 when he was elected a director of the corporation and a member of its executive committee. Hazlett, after graduation from college, was employed by West Penn Steel Company in the sales department, later became sales manager and then president of Eastern Rolling Mill Company, and came to Jones & Laughlin Steel Corporation in 1938 as manager of strip and sheet sales.

Tube Turns, Incorporated, recently has added G. Bronson Philhower to the staff of its New York office, to work in the metropolitan area and in New England. Philhower, who was a naval engineer in World War 1, has for years been connected with Eastern pipe fabricators and distributors, and has had experience covering the field from mill apprentice to district sales manager.

The Midvale Company, Nicetown, Philadelphia 40, has announced election of Henry H. Ziesing as vice president in charge of sales. He replaces Stuart Hazlewood who has resigned after 41 years with the company. The resignation and replacement become effective April.

The Davison Chemical Corporation, Baltimore 3, Maryland, has announced formation of a process division with E. B. Dunkak as manager. It offers the chemical, petroleum, steel and allied industries a complete design and equipment service.

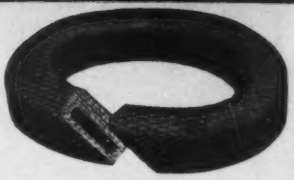
Worthington Pump and Machinery Corporation, Harrison, New Jersey, has announced appointment of William O. Wilson as commercial vice president with headquarters at the company's Chicago district office, 400 West Madison Street. With the company or its predecessor since 1898, except for a two-year period starting in 1911, Wilson has been manager of the Midwest district at Chicago since 1937.

Pennsylvania Salt Manufacturing Company moved its New York office to 40 West 40th Street, New York 18, N. Y. The New York office is the headquarters of two of the company's sales districts, one headed by F. G. Rodenburgh and the other by C. A. McCloskey.

The C. M. Kemp Manufacturing Company, Baltimore, has appointed F. H. Yocum and A. H. Goode, Graybar Building, New York, as representatives in the New York City area.

Wheelco Instruments Company, 847 W. Harrison Street, Chicago, has been reorganized following purchase of its assets by Fred A. Hansen and Cary H. Stevenson, vice presidents of Lindberg Engineering Company, and several as-

INDUSTRIAL
PACKINGS . . . GASKETS



HIGH PRESSURE PACKING
Designed for service on reciprocating rods and valve stems handling steam, gas, and air. Made by enclosing an asbestos and non-hardening rubber core in a wrapper of woven asbestos cloth. Style 200, Ring; Style 201, Spiral, and Style 202, Coil.
Write or wire
Sterling Packing & Gasket Company
1701 Nance, Houston, Texas

Sterling
MEANS QUALITY

QUICK TURBINE REPAIRS

If you need dependable Turbine repairs **in a hurry,** call us. We are completely equipped to repair and dynamically balance turbine rotors and any High Speed rotating elements in our modern shops.
25 Years Successful Experience

GULF ENGINEERING CO., INC.
"Service, Not Promises"
307 M & M BUILDING, HOUSTON, TEXAS
916 S. PETERS STREET, NEW ORLEANS, LA.

UNIBESTOS
PIPE INSULATION

For Temperatures up to 750° F. and 1200° F.
Most efficient molded covering.
Single layer construction.
Thicknesses up to 6".
Made half-sectional for pipe up to 30" diameter.
95% to 100% salvageable.
Low installation cost.

The **INDUSTRIAL INSULATORS**
HOUSTON, TEXAS ★ SHREVEPORT, LA.

Power Turns the Wheels of Industries Now Producing War Materiel

Ladish Forged Steel Flanges...sizes from ½" through 24" and in pressure ratings ranging from 150 to 2500 p.s.i....serve in power plants everywhere, helping supply the power needed to back the attack.

ARMY E NAVY

L

FITTINGS DIVISION

TO MARK PROGRESS

LADISH DROP FORGE CO.

CUDAHY • WISCONSIN

YOUR WATER SYSTEM

Might Be Called for Extra Duty Tonight

FIRE—that killer of man and destroyer of property strikes suddenly and without warning! Standing guard, after performing its daily duty, is your water system. If it bears the name of LAYNE, be assured that it has a great stand-by reserve of power and productivity ready to be unleashed when the emergency call comes.

In many, many cases Layne Well Water Systems, due to their extra reserve of power and productivity, have saved untold thousands of dollars worth of property in cases of sudden emergency.

Layne Well Water Systems are specifically built to give their owners much more than normal daily operational service. They are built to give protection to property and lives.

If your city or manufacturing plant needs more water, please remember that Layne Well Water Systems produce great quantities at exceptionally low cost and at the same time provide an extra reserve of power and productivity that stand guard in cases of emergency.

For fully illustrated literature on Layne Well Water Systems, address Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Western Co. of Minnesota, Minneapolis, Minn. ★ International Water Supply Ltd., London, Ontario, Canada

LAYNE

WELL WATER SYSTEMS

DEEP WELL PUMPS

BUILDERS OF WELL WATER SYSTEMS FOR INDUSTRIES AND MUNICIPALITIES

sociates. Business will be continued at the same location. Richard Schoenfield, who was vice president of the company before reorganization, continues as vice president in charge of sales for the new company.

Sheffler-Gross Company announces that Harold M. Miller has joined its organization as field engineer. He is a graduate of Washington and Lee University and has spent ten years with Sinclair Refining Company at Marcus Hook in connection with maintenance of instruments and controls. More recently he was with Blaw-Knox Company where he was engaged in design and installation of instruments and controls.

Hanlon-Waters, Inc., Tulsa, at its annual meeting February 22 elected as directors Edward F. Deacon, president of Climax Engineering Company, Clinton, Iowa, and The McAlear Manufacturing Company, Chicago; Owen L. Coon, chairman of the board of General Finance Corporation, Chicago; and James E. Allison, attorney for the Hanlon companies. Allison was elected secretary.

The old officers of the company, consisting of E. I. Hanlon, chairman, M. F. Waters, president, and J. H. Boyle treasurer, were re-elected. L. J. Griffey, chief engineer of Hanlon-Waters for 10 years, was made vice president and C. W. Snyder was appointed chief engineer.

Hanlon-Waters, Inc., manufactures automatic control equipment and oil and gas separators and bolted tanks. Climax Engineering Company manufactures gas and diesel engines, power units and generating sets. The McAlear Manufacturing Company manufactures automatic control equipment for the industrial steam power plant field.

Jones & Laughlin Steel Corporation and Frick-Reid Supply Corporation have joined forces in enlarged offices in the Oil & Gas Building at Houston.

This is made possible, an announcement said, by the recent appointment of Frick-Reid as exclusive distributor of Jones & Laughlin oil-country tubular goods east of the Rocky Mountains and is in line with the policy to consolidate parent and subsidiary company offices in order that a more direct service may be maintained for their respective trades.

The Frick-Reid Supply Corporation organization, under H. H. Wilson, vice president, formerly maintained offices on Quitman Street, where its store and warehouse are located. Moving to town with Wilson are C. B. Moore, city salesman, G. S. Emerson, salesman, and T. L. Lewis, who recently joined the organization as district manager of tube sales. G. E. Tyson, salesman, and J. T. Batchelor, chief clerk, formerly in tube sales for Jones & Laughlin Steel Corporation, have been appointed to those positions with Frick-Reid.

F. D. Winslow, district sales manager, for Jones & Laughlin Steel Corporation, continues in charge of sales on mill products, other than oil-country tubular goods.

Petroleum Conversion Corporation, Elizabeth, New Jersey, elected Alfred R. L. Dohme its president at the annual meeting of directors in February. From 1911 to 1929 he was president of Sharpe & Dohme and he is still a director of that company.

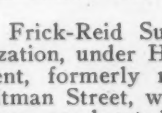
Petroleum Conversion Corporation is owner and licensor of the TVP thermal refining process.

WANTED

MECHANICAL ENGINEER

Graduate mechanical engineer with 7-10 years oil refinery engineering experience wanted for development work. Permanent position offered by a long-established AAA-1 company, manufacturing fractionating and pressure vessels, heat exchangers, cast-steel flanged fittings and other equipment for the petroleum and process industries. Knowledge of cast-steel header boxes desirable. Successful applicant will report directly to plant manager. Location in southwestern city where ample housing facilities exist. If you feel qualified for this key position in an expanding organization, apply giving full information and enclosing small photograph. Replies will be held strictly confidential. Maximum salary—$5000 per year.

Address: **Box 70, c/o Petroleum Refiner, Houston, Texas.**



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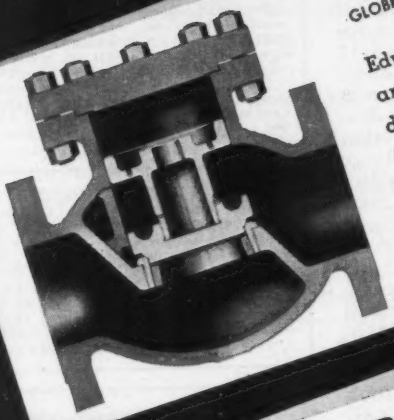
FT. WORTH AND HOUSTON

Edward CHECK VALVES

CAST STEEL LIFT CHECKS

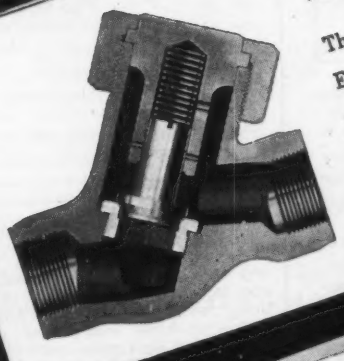
GLOBE AND ANGLE, 2½" to 14" 150 LB TO 2500 LB SP



Edward piston type check valves cut shock, slam and clatter to the barest minimum through exclusive design features that cushion disk action yet give fast, sure closure. Hour-glass disk-piston assembly moves in mirror smooth body-piston chamber, fully guided by three streamlined guide ribs integrally cast with body. Full area body gives maximum free dom of flow. Flanged or welding ends.

FORGED STEEL PISTON CHECKS

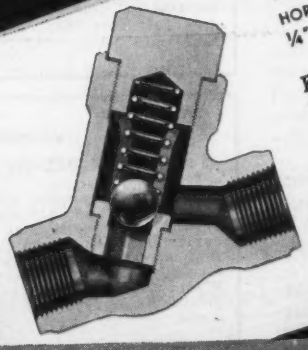
HORIZONTAL OR VERTICAL, ¼" TO 2" 150 LB TO 2500 LB SP



The same freedom from damaging shock that characterizes Edward cast steel check valves is a feature of Edward forged steel piston type check valves. Spring loaded in sizes under 1½ in. for tight, sure seating. Internal parts are designed for full flow area and cushioned closing action. Flanged or welding ends.

BALL CHECKS

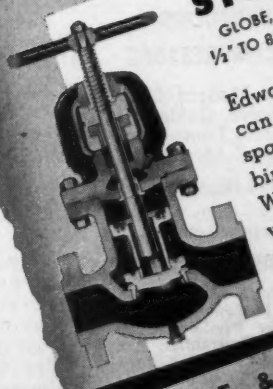
HORIZONTAL, VERTICAL & ANGLE ¼" TO 2" 150 LB TO 6000 LB



For viscous fluids or hydraulic service, Edward ball checks are ideal. The stainless steel ball, carefully mated to EValloy stainless steel seat is guided by two integral steel ribs. A spring aids seating.

STOP-CHECKS

GLOBE, ANGLE AND SEPARATED ½" TO 8" 150 LB TO 2500 LB SP

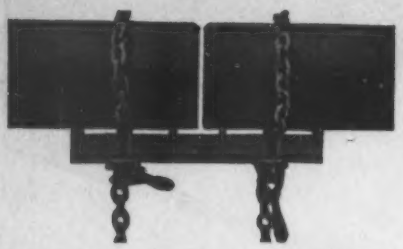


Edward stop-check valves can be used where cost or space limitations make combination valves desirable. Widely used for feedline service. Available with handwheel, gear or motor operation.

THE EDWARD VALVE & MFG. CO., INC.
East Chicago, Indiana

E V

EDWARD *Steel* VALVES



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R.E.F.

Mathieson President Retires And Successor is Chosen

E. M. Allen, president of The Mathieson Alkali Works, New York, has announced his retirement, effective January 1. He will continue as chairman of the board of directors. Allen became president of the company in 1919 and has been chairman of the board since 1938.

G. W. Dolan has been elected president to succeed Allen. Dolan joined the Mathieson organization in 1930. He has held various positions of responsibility and was elected executive vice president in 1941.

Aviation Gasoline Manufacture

"Aviation Gasoline Manufacture," by Matthew Van Winkle, an edition of The Pennsylvania State College Mineral Industries Series, has been published by McGraw-Hill Book Company.

The book summarizes information concerning the manufacture of aviation gasoline as a reference for those who are interested in this field of refining—a field that has been accelerated by war conditions. Describing production of aviation gasoline as an industry within an industry, the author reviews methods that have made possible the current large production of relatively pure hydrocarbon compounds used in blending fuels for fighting airplanes.

Matthew Van Winkle, the author, is instructor in chemical engineering at the University of Michigan and formerly was assistant professor and supervisor of the Petroleum and Natural Gas Extension Division of The Pennsylvania State College.

The book may be had from the Book Department, The Gulf Publishing Company, Box 608, Houston 1, Texas. The price is $3.

MERIT AWARDS

Awards of merit have been made by the government to the following companies:

Alloy Steel Products Company, Inc., Linden, New Jersey, a star for the Army-Navy E pennant received last summer.

The Brown Instrument Company, Philadelphia, a division of Minneapolis-Honeywell Regulator Company, a renewal of the Army-Navy E award "for splendid production in such volume as to justify a renewal."

Cochrane Corporation, Philadelphia, the Army-Navy E award for excellence in production.

The Cooper-Bessemer Corporation, Mount Vernon, Ohio, a second gold star to be added to the Maritime M pennant "in recognition of your continued achievement in completing wartime schedules in the manufacture and delivery of merchant ship components."

The Edward Valve & Manufacturing Company, East Chicago, Indiana, a second gold star to add to the Maritime M pennant "for continued excellence in the production of valves."

Hanlon-Waters, Inc., Tulsa, the Army-Navy E award for excellence in production and for "making an outstanding contribution to victory."

Mixing Equipment Company, Rochester, New York, the Army-Navy E pennant for achievements in the production of fluid-mixing equipment.

Worthington Pump and Machinery Corporation, Harrison, New Jersey, a third star renewal of the Navy E award; the fourth consecutive Navy E pennant in addition to the United States Maritime Commission's M Award and Victory Fleet Flag.

Worthington's Moore Steam Turbine Division, Wellsville, New York, a second renewal star for its Army-Navy E pennant.

James E. McDonald, 53, General Sales Manager of The Edward Valve & Manufacturing Company, East Chicago, Indiana, died February 25, 1944.

He first joined the Edward organization in 1917 and served as chief engineer and plant superintendent before becoming sales manager. During his career he made many contributions to the development of steel valves for high temperatures and pressures.

Chemical Engineer desires to return to petroleum industry. Available for process engineering or supervisory position in plant. Eight years varied experience in operation and design of refinery processes including design of fractionation and absorption equipment. Also experience in project engineering, construction and operation of chemical plant. Address: Box 200, c/o Petroleum Refiner, Houston, Texas.

WANTED: Poly Plant Operators—Light Ends Operators—Instrument Men—Metal Inspector—Pumpers: For new Aviation Gasoline Refinery consisting of Catalytic Cracking, Alkylation, and Isomerization units. Location, Middlewest. In reply give detailed outline of previous experience, education, draft status, and required earnings for 48-hour week. Address: Box 590, c/o Petroleum Refiner, Houston, Texas.

REFINERY SUPERINTENDENT

Experienced in both operations and maintenance. Graduate engineer 35 to 50 years of age who has a good record as a practical operating man, administrator and handler of men.

Successful independent oil company with completely integrated operations located in Ohio valley. Address: Box 777, c/o Petroleum Refiner, Houston, Texas.

HELP WANTED

"Chemical Engineers with experience in any of the following petroleum refining operations (1) light ends recovery equipment, absorbers, stabilizers, etc. (2) catalytic cracking equipment or (3) crude distillation equipment and similar processing units. State in detail educational background, positions held with detailed explanation of work handled, age, and number of dependents also draft status." Address: Box 608, c/o Petroleum Refiner, Houston, Texas.

WANTED
PUMP DESIGN ENGINEER

Capable of designing single and two-stage centrifugal pumps. Also with executive ability and mechanical knowledge for supervision of engineering department. Position is permanent with reliable, well-established company located in the Middle West, that has been in business 30 years producing pumps and other process equipment.

In reply state experience, education, age, marital status, draft classification and salary expected. Include snapshot.

Replies **strictly** confidential. Address: Box 333, c/o Petroleum Refiner, Houston 1, Texas.